SCIENCE

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WHAT IS INDUSTRIAL SCIENCE?[1]

INDUSTRIAL education is now the most pressing of all educational problems. It is, moreover, a wholly new problem; since the schools have never seriously tried, until very recently, to grapple with it. Up to the beginning of this twentieth century, the working hypothesis of the schools has been that the best possible education for every boy and every girl was that portion of a college education which each was able to secure. The banner of education bore the inscription: "Keep the path open for every child from the kindergarten to the university." The intention of this motto was good, in that it was supposed to express the idea of equal opportunity for all; but it was interpreted by schoolmen to mean that the college course was infallibly the best possible course for everybody; and that, therefore, the elementary schools and the high schools were doing their work most efficiently if those who survived their ordeal could successfully get by the guards at the gates of the colleges.

The rapid development of educational insight in the past decade has shown the fallacy of assuming that the same opportunity for all was synonymous with equal opportunity for all. The desire to discover what equal opportunity for all might mean has led to much careful study of the individual differences and of the individual needs of pupils, and also to some careful analyses of the foundations of school philosophy. These studies have shown school-

[1] Presented at the meeting of the Central Association of Science and Mathematics Teachers at Des Moines, November 29, 1913.

men that, turn and twist as they may, they are always face to face with three mighty facts. These are: (1) That the present age is an age of machines, with a new set of ideals of its own; (2) That the schools are still too much under the influence of the ideals of a grammatical, machineless age which is now rapidly passing away; and (3) That not only industry, but also the public at large, is demanding a new type of schools whose graduates shall feel at home in and be able to cope successfully with this modern world of machines.

Now facts are facts, whether we like them or not; and it is a hopeful sign of growth that schoolmen are no longer trying to obscure these three great facts by devout longings for the will-o'-the-wisp of culture for its own sake. We schoolmen have reached the point where we are seriously trying to harmonize these relatively new facts with the rest of our knowledge. Such, at least, is my attitude in trying to define what, in the presence of these facts, science might do to help the schools to usher in a new era of real industrial education.

That we are all trying to find out what industrial science may mean is proof that we are all pretty well agreed that the work now done under the name of science in most schools can not fairly be called industrial science. Whether that work may justly be called science or not is another question, and one about which there have been and still are perfectly honest differences of opinion. But this is not the topic under discussion. The problem before us is: What is industrial science? and I assume that all are ready to agree that few, if any, have yet defined it in action; *i. e.*, that few, if any, of the present school courses in science can be classed under that head. For the sake of definiteness, this problem will first be discussed for the special case of physics. The conclusions reached are equally valid for the other sciences.

Current courses in physics do not meet the demand for industrial physics because the leading ideas on which most of the elementary work in physics is based are fundamentally different from those required by industrial physics. Current courses in elementary physics have been planned by students of advanced physics under the spell of a very one-sided appreciation of what the essential elements of physics are. For when a student undertakes to grapple with such works as Newton's "Principia," or Maxwell's "Electricity and Magnetism," he finds it no easy task merely to follow the argument and to reproduce the results. Hence he naturally acquires a great admiration for the intellectual genius of the men who created such works. He knows, moreover, that his academic success depends on his ability to reproduce these works as intellectual feats only. When he himself becomes a teacher of elementary physics, he very naturally falls into the habit of presenting physics as a series of intellectual feats—of facts and demonstrations and theories and nothing more. Hence current courses have been framed and many text-books have been written with the sole purpose of teaching the laws and principles of elementary physics as coldly intellectual propositions.

As teachers of elementary physics we have thus been filled with a zeal to impart to others the principles that have cost us so much labor. We have tried to get beginners—mere infants in physics—to repeat Newton's laws of motion with some show of intelligence as to their meaning; we have had them figure coefficients of restitution, although none of us ever met one in real life. We have even let them speculate about atomic magnets and ether and

the kinetic theory of matter, long before they have enough facts at their disposal to make these theories comprehensible. This was natural enough—did not the great artists who created the science of physics do these things? But, somehow, it did not work. It was all too unusual and too abstract and too remote from the interests of real boys and girls. It was too coldly intellectual to satisfy the demands of a world of action and emotion. It was too much like learning and trying to apply the fixed rules of grammar to be really exciting. We therefore had to give it up and try again.

In the second attempt we shifted our enthusiasm from the works of men like Galileo, Faraday and Helmholtz, to the achievements of men like Watt, Stevenson and Wilbur Wright. In other words, we seemed to be giving up trying to make scientific artists out of all of our pupils, and shifted the emphasis over to an ambition for engineers. Not that we forsook entirely the traditions of the past—far from it. We merely tried to use the inventions and achievements of engineers as a bait with which to catch the unwary on the laws and principles aforesaid. We tried to use a boy's natural enthusiasm for steam engines as a means of painlessly inoculating him with the errors of thermometers, the laws of boiling, the laws of fusion, the laws of saturated vapors, and the mechanical equivalent of heat.

This second attempt was a great advance over the first, in that it showed some recognition of the rights of the victims—it took some account of the desires and emotions of the pupils. But even this plan has not succeeded. It is at best a sorry practise to try to make any subject-matter interesting after it has been selected on grounds other than the interests of those who are to learn it. This practise has not and will not satisfy the demands of industry or teach boys and girls to cope successfully with a world of machines. If it had and would, we would not now be still seeking the meaning of industrial physics.

From the first of these experiences we have learned that an age of machines is not satisfied with a physics teaching that makes a few men competent to reproduce statements of the laws of physics as coldly intellectual propositions at college entrance examinations. From the second we are discovering that the public does not consider that it is getting its money's worth out of a physics teaching that turns out a moderate number of boys and girls with a moderate amount of information about engines, trolleys, telephones and wireless, and some painful memories of a few laws and principles as an added ornament.

Both of these attempts at teaching elementary physics in an age of machines have failed for the same reason; namely, because it is not possible to gain an understanding of this age merely by counting cogs and levers, or by measuring moments and coefficients, or by speculating about atoms and ether. We have in it all overlooked the fact that the works of the great artist creators of the science of physics and those of the great engineers of physics are not intellectual or material products plain and simple, but are the expressions of a mighty spirit worked out through keen intellects into tangible form. The great physicists are great not because they merely have more brilliant intellects than most people. There are relatively many brilliant intellects and relatively few great scientists. The great engineers too have not been great merely because they possessed great intellects. Both the great physicists and the great engineers have been great because they were inspired with the spirit of science. Keen intellects are, of course, necessary too, but they are not the

determining factor. The power in such men has been, is, and always will be found in the spirit with which they work—in their disinterested devotion to their tasks and their sublime faith in the harmony of nature and in the possibility of achieving what they have undertaken.

This is no new or startling theory. It is a very venerable fact. Yet somehow it seems to have escaped attention entirely in the organization of elementary physics courses. Since the spirit of science is the dominant factor in making a great scientist, we physics teachers have not been quite bright in thus omitting it from our courses. We have been trying to play Hamlet, but have inadvertently omitted Hamlet altogether. It is encouraging to note, however, that the importance of this omission has just begun to attract attention. Some progressive teachers include the biographies of physicists in their courses, and some progressive authors include the portraits of great physicists in their texts. If the materials of physics can not be presented in such a way as to arouse a real live scientific spirit inside a boy, it may be well to show him pictures and to tell him stories of men who had it.

Yet, after all, we physics teachers are not so very much to blame for omitting the scientific spirit from our courses. If we had been inspired with it when we were children, all would have been different. When we were young, nobody knew what it was. Great scientists just felt it and lived it, but nobody seemed to think of trying to describe it, or to define it, or to tell how it felt all welling up inside and overflowing in laws and principles. There have been many attempts from Aristotle down to the present time to define the scientific method of thinking. But it is only very recently that the effort has been seriously made to portray in words just how the scientific spirit feels when it is once safely lodged inside a man.

Now that we are beginning to know something about how it feels to have the scientific spirit inside one, the stone which the builders of elementary physics courses rejected is to become the headstone of the corner of the new industrial physics. For, though they may not know it yet, the thing that the industries need most just now is this self-same scientific spirit. The public is demanding it, employers are seeking it, trades unions are hunting it everywhere, even in socialism, and the world at large in this machine age is crying out piteously for it. If we are ever to have an industrial teaching of science, it will be of a sort that succeeds in developing the scientific spirit inside people. It will be a kind of teaching that does not emphasize the loading of the intellect with facts, principles and theories; but rather one that sees to it that at all costs the hearts of the pupils are filled with the scientific spirit. Hence if we would go forward with the development of industrial physics, we must first recognize what is the essential thing in the scientific spirit.

The essence of the scientific spirit is not, as has been generally supposed, a method of thinking. It is not the intellectual process that has been divided into the steps called observation, induction, hypothesis, verification. This process, if it signifies anything real, is at best but one of the modes in which the presence of the scientific spirit inside is made manifest. Many of us have consciously tried, and as consciously failed, to impose this order of thought on our pupils with the idea that we were thereby serving science. We have failed because the essence of the spirit we want is not of this sort.

The essence of the scientific spirit is an emotional state, an attitude toward life and

nature, a great instinctive and intuitive faith. It is because scientists believe in their hearts that the world is a harmonious and well-coordinated organism, and that it is possible for them to find harmony and coordination, if only they work hard enough and honestly enough and patiently enough, that they achieve their truly great results. It is this faith inside them that inspires them to toil on year after year on one problem. How else could Darwin have toiled on all those years to find coordination in one direction? Was it because he wanted to make himself unpopular with the theologians and to set their tongues to wagging against him all over Christendom? Or was it because the problem interested him, and because he knew in his heart that there must be such a thing as law and order among living organisms, and that such order could be found if only he worked patiently enough and honestly enough?

The same is true of inventors and engineers. Their greatness does not depend primarily upon the fact that they have keen intellects and use scientific methods of thinking. When Wm. McAdoo conceived the idea of the Hudson River tunnels, it was not the idea alone that made him achieve them. Many others had thought of tunnels under rivers before. It was rather his belief that the thing was worth while, backed by an indomitable faith in things and in men. He knew in his soul that the people needed this and that it could be done, and he knew it with such energy that he succeeded in accomplishing it. Brains were useful and even necessary too; but the real source of his success was the will to do, and this in turn comes from a profound and indomitable faith that there is law and order in the world and that therefore it can be done.

Look where you will at physics in real life, and you will always find that the heart and soul of it is an unquestioned faith in things and in the harmony and relatedness of things, united with an unquestioned faith that it is possible for any man to find harmony and relatedness among things if he devotes himself whole-heartedly to the task.

Look where you will at physics-teaching in the schools, and what do you find? Hundreds of teachers—all of us—bustling around with definitions of the unit in physics bound over our eyes. Open any one of these definitions, and what do we find? That the teachers must see to it that each pupil does not less than 30 experiments described in the following list; that teachers should use algebra and geometry when they find it convenient; that teachers should not confuse the pupils with too elaborate apparatus nor allow them to obscure their results under unintelligible units. Hereunto is appended a mighty syllabus, which has cost some committee many hours of hard labor, and which contains the united wisdom of the committee as to what must be included in the course. Such a syllabus of topics we all carry with us always lest we forget some weighty or massive point, and so leave a vacant space in the logical system with which we are trying to adorn our pupils.

So long as we teachers insist on keeping such definitions and such syllabi before our eyes, so long will a real industrial physics be impossible. The syllabus of industrial physics contains only one topic, and that is a topic that no teacher or committee of teachers has ever yet thought of putting in any syllabus yet made. This may seem strange to us at present, with our eyes all blindfolded in our present stately game of blind-man's bluff; but twenty years from now, when our eyes have been opened and industrial physics is in full swing everywhere, the tables will be

turned. We will then wonder how we ever could have been such silly boys as to have been blinded by syllabi that utterly fail to mention the one and only thing that gives science its final and distinctive claim to a leading place in any system of truly democratic education.

The syllabus of industrial physics will be brief and full of meaning. It will read somewhat like this: Topics I–XC, Paragraphs A–Z. THE SCIENTIFIC SPIRIT. This includes: (1) a militant faith in things, in the harmony of things, and in what men can do with things; (2) an eagerness to seek facts and to treat facts as facts; (3) an imagination that is able to see old facts in new perspectives.

This syllabus contains no topics like those in which the current syllabi abound, because there are plenty of books in which all these topics are fully treated. If a man has the scientific spirit, he will look them up in books whenever he needs any of them so that they come to have meaning for him in the joyous work of living. This is no more than he now has to do if he wants really to use those now covered in physics courses in any important undertaking.

This syllabus contains no required list of experiments; because, to a man with the scientific spirit, all life is one magnificent series of experiments.

This syllabus, finally, contains no petty directions to the teacher; because the result demanded is emotional in nature and depends on the tact, the intuition and the scientific spirit of the teacher. Fortunately no one has yet attempted to formulate set rules for the development and administration of the scientific spirit, so there is hope for success here by a real live teacher.

Like all truly great things, this syllabus is beautiful because of its simplicity. It is, moreover, the same for all the sciences. Committees will not have to waste much valuable talent haggling over its details, but can spend the time thus liberated in learning to apply it. Hence, when it has once been adopted, progress in industrial science will be rapid.

There are a number of reasons why it is certain that this simple syllabus is the one that industrial science is going to adopt. In the first place, this is the syllabus that the colleges now want to have adopted. It is the syllabus that the universities use in their advanced work, and the one that the colleges would like to adopt for their own use if only the secondary schools would be good enough to forget the old syllabi that the colleges made. Although the colleges really want to have this new syllabus adopted, none have yet had the bravery to say so openly; because the new syllabus demands a result which can not be examined in two hours by the college entrance examination board. Even the colleges that lie outside the influence of this board, and that admit wholly on certificate, still like to hold on to the possibility of giving entrance examinations if they ever should want to do so. Standards of something-or-other seem somehow to be maintained by this process.

In the second place, the elementary schools are demanding the adoption of this syllabus of industrial physics. In fact, the elementary schools are seriously trying, with their nature study and their general science, to put it into effect themselves. They know that most children come to the first grade with marked symptoms of scientific spirit cropping out all over them, and they know that these same children leave the eighth grade with their scientific spirit a sad caricature of its original self. But the elementary school can not both make its own teachers and teach the children. The teachers must come from above; and hence progress will be slow until the

high schools, the normal schools and the colleges take hold and help too. That it is decidedly to their own selfish interest to do this is perfectly obvious. If the scientific spirit of the children could be preserved instead of deadened in the schools, the work of the higher institutions would change utterly—would become veritably inspired.

But finally, and most important, the syllabus for industrial science is the one just outlined because it is the one that commerce and industry and the public and the world at large are demanding of the science teachers. This is evident because the history of the development of our civilization shows that, since the destruction of Rome, progress has consisted in a continual series of triumphs by men who believed in things over men who believed in words. Magellan believed in things; and when his fleet had sailed off the west end of the world and sailed safely back on to the east end of it without being seriously inconvenienced by the feat, the words of those who liked to prattle about flat worlds became rather insipid. Watt, and Stevenson and Fulton believed in things so vigorously that they actually succeeded in reducing this earth to about one-eighth of its former size, and in expanding the strength of men to the nth power. No amount of talking could ever have accomplished that. The telegraph, the telephone and wireless have compressed the world to still smaller dimensions. The Hanseatic League, the craft guilds, the so-called Renaissance, the development of a merchant marine, the expansion of industry and commerce, are all the work of men who had faith in things. The effects of this work are not material only; for the tangible results of it have been silently working on men's ideals all the time and as silently reconstructing them. It has done more to make men comprehend the idea of universal brotherhood than all the words that were ever uttered about it.

All this is work of the scientific spirit as here defined. It is forcing on us new conceptions of goodness and justice, new ideals of success and failure. It is even developing in us a new faith; for the scientific faith in things and in the possibility of finding among things a harmony which includes them all is now expanding into a faith in men and in the possibility of finding among men a justice which includes them all. This fact appears explicitly in the work of Taylor and others on scientific management, and implicitly in the change that is rapidly coming over business methods everywhere.

The prophets of our time are telling us that a few years ago the general idea underlying business and industrial transactions was "get all you can out of everybody and give as little as you can in return." Business is business was the motto. While this idea still pervades much business, the most successful firms at present are those which have felt the inspiration of this expanded spirit of science and which therefore realize that this idea is, in the light of the facts, a false one. To be permanently successful in business or industry, one must deal with the same people for long periods of time; and this is possible only when all parties to the transaction are satisfied. All parties will be satisfied only when there is mutual confidence in one another and a recognition that all have been treated fairly and justly. This means that business and industry are coming more and more to be guided by men who have a faith in men as well as in things, and who believe that there must be a social and economic order which will give a justice that is best for all and which can be found if men seek it long enough and honestly enough. Business men are coming to this faith, not be-

cause it is a pious moral thing to do, but because it produces tangible results. If workmen feel that they have been treated justly, they are happy and take interest in their work; and happy and interested workmen are more efficient than unhappy and rebellious ones. It pays to treat men justly and to seek a justice that is best for all. The scientific spirit always pays when intelligently applied.

Now it is because the people sense the fact that this expanded and more mature scientific spirit is coming to the front in business and in industry, and because they see that it pays, that the public is demanding the development of scientific spirit in the schools. The situation is full of meaning for teachers of science. In the first place, it is evident that the public has come to believe in the scientific spirit. The public has tasted of this spirit and is bound to have more. If the present schools will not supply it, the public will either make it themselves in business, or found other schools that can make it. Are not the business men of Illinois even now trying to have a second set of schools established in the hope of securing just this? Present schools are beginning to have competition in this development of scientific spirit. Syllabi of facts are no longer the sacred symbols of the faith—it is spreading of itself wherever men are honestly trying to cooperate in work that is significant to them. If we science teachers do not wake up to this situation, our jobs will soon be gone, and the schools may be reduced to the function of teaching the three R's.

Besides, we science teachers are really rather dull when we allow our individualities to be submerged by syllabi and definitions of units. Why do we insist on hiding our light under a bushel of facts and principles of elementary science, all of which can be bought for a dollar and a quarter from any one of a dozen enterprising publishers? And why do we all suppress our personal enthusiasms and all try to make ourselves up to look each as much like the other as possible, and all as much as possible like forty experiments from the following list? That we do so is the more surprising when we realize that we are thereby not merely faithless to our trust as guardians of the scientific spirit, but that we are in addition actually making for ourselves a whole lot of tedious and unnecessary work. It is a great deal easier to develop scientific spirit in lively youngsters than it is to suppress their liveliness with an inherently barren and uninteresting syllabus. It is vastly more fun for the teacher too, if he will just be himself and let his enthusiasm spread through the class. He will not have to be a slave to examination papers and notebooks if he can get the class to working on problems that are really significant and worth while in their eyes. When he sees a class so absorbed in the things they are doing that they forget when it is time to go to the foot-ball game, he can be perfectly sure that they have acquired the scientific spirit and hence need no further examinations. They will then have mastered the syllabus of industrial science.

That we are rapidly drifting toward such work is shown by the success of those experiments in which boys spend half their time in school and the other half in some shop. The shop lends reality to the school work and makes it seem worth while. But the schools might make their work seem worth while without the shop, if only they would adopt the syllabus of industrial science in place of the syllabi that have been standardized by the authority of official utterance of the committee of ten. Those syllabi belong to the age that trusted in words; the syllabus of industrial science

belongs to the age of machines, which is founded on a faith in men and in things.

If I were to stop here, I would have defined industrial physics in its fullest sense. I would not, however, have given any specific directions as to how to go to work to frame a real course in industrial physics. What subject-matter shall be used? What topics? These are very practical and very pressing questions in the every-day routine of schools. To such questions as these there is but one answer; namely, use any subject matter in which you can get your pupils so absorbed that they forget everything else but the thing they are doing. Use the subject-matter of the old syllabus, if you want to, and if you think that you have the genius so to clothe it with significance that all the students will become absorbed in it. It is not absolutely impossible to do this. Experience seems to indicate, however, that teachers will have more success if they change the type of problem from the kind in which only physicists are naturally interested to a kind that has more local color and that the rest of the world find essential. For example, instead of trying to interest the pupils in the errors of thermometer scales, the specific heat of aluminum, or the coefficients of expansion of iron and brass, why not set the class on the problem of finding the best grade of coal in town? Or perhaps they would find the relative efficiencies of various types of cooking utensils and gas stoves a fruitful topic? If such topics as these seem to lack the appeal to the creative instincts, the design and construction of an electric lighting system for a house or a miniature town might prove more stimulating. If this still seems to lack the vitality of the real thing, organize the class into a scientific information bureau and invite the citizens to send in their real problems to the class for solution. A plan of this kind, in operation in Springfield, Mass., was described in the November number of *School Science and Mathematics*. It suggests rich possibilities.

The best example of industrial science that I know of is the work of the corn clubs and the canning clubs of the south. This work was started and is being guided by the General Education Board, and is wholly independent of all school systems. It has, therefore, not been standardized to death. Corn clubs are for the boys, and their purpose is to see which boy can raise the greatest number of bushels of corn per acre. The boy who, by his careful attention to this work, actually produced 210 bushels from his acre, as well as all the other boys involved, incidentally have been raising other things than corn. They are beginning to have faith in things and in what they can do with things. They are beginning to appreciate the value of facts as facts. Their imaginations are at work, figuring, perhaps, how they may slip the corn belt down south and leave Illinois, with its measly 34 bushels per acre up in the cold. They are contributing to the world's work. They are having real industrial science.

In like manner, the canning clubs are for the girls. They meet at the houses of the members and can tomatoes which they have themselves raised. They work with enthusiasm, and have so far perfected their product that, in open market, they get two cents a can more for it than is paid for factory brands. Unlike factory hands, they are happy in their work. They are learning that the scientific spirit pays. Like the boys, the girls have been raising other things as well as tomatoes. They too are beginning to master the syllabus of industrial science, and to have faith in things and in facts, and to see the world in a new perspective. If this sort of work continues and develops farther, who knows but that

the north, with its highly standardized school system, may have to import its scientific spirit from the corn and canning clubs of the south? If we science teachers wish to avert such a humiliating catastrophe, there is but one thing to do; go to work and develop an equally efficient industrial science in the schools.

This is the only thing that will statisfy the present demand of the public and convert the schools of a machineless age into educational institutions that will turn out pupils competent to understand and to cope with this age of machines. For machines are one of the products of science; and if they have caused misery and slavery among workmen and have reduced human beings to machines, it is because they have been owned and manipulated by men who did not possess the scientific spirit. Machines are bound to master and to control men who try to manage them with words or with the ideals of the past machineless age. Only men with the true scientific spirit are able to understand the real meaning of machines and to use their power for the uplift of humanity. Only men with the sacred faith can ever hope to master and to control them permanently.

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THE FUNCTIONS OF AN ENVIRONMENT[1]

In its nature the present paper falls within the field of abstract physical science, and it can, I fear, interest biologists only through its conclusions. But there is reason to believe that by means of these conclusions a trustworthy foundation for the systematic study of the environment may be established.

The result of my recent inquiry into the relation between the organism and the environment[2] has been, as I believe, proof that a hitherto unrecognized order exists among the properties of the elements. This new order is, so to speak, hidden, when one considers the properties of matter abstractly and statically. It becomes evident only when time is taken into consideration. It has a dynamical significance, and relates to evolution.[3] It is associated with the periodic system of the elements in somewhat the same way that the functional order is related to the structural order in biology. Hence it is not independent of the other order, but may be said to lie masked within it.

This is no novel experience, that the consideration of phenomena in time should lead to new points of view. In truth, it might almost have been said *a priori* that a new order must be revealed by a study of the properties of matter in relation to evolution.

This order may be described abstractly as follows:—The properties of matter are not evenly distributed among the elements, nor in such a manner as can be explained by the laws of chance, nor are they altogether distributed in the manner which the periodic system describes. If the extremes be considered, all the physical and chemical properties are distributed with the very greatest unevenness, so that the extremes are concentrated upon a few elements, notably hydrogen, oxygen and carbon. As a result of this fact there arise certain characteristics of the cosmic process which could not otherwise occur.

The characteristics which make up this unique ensemble include the greater number of characteristics and especially the most important and the most conspicuous physical and chemical properties. This order has for cosmic and organic evolution extremely important results—maximal stability of physico-chemical conditions and maximal complexity in the physico-chemical make-up of the surface of a planet; further, the possibility of maximal complexity, durability and activity of physico-chemical systems in such an environment.

All the considerations upon which these results are based are purely physico-chemical,

[1] Read before the American Society of Naturalists, December 31, 1913.

[2] "The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter," New York, The Macmillan Company, 1913.

[3] I do not, of course, refer to radioactivity, and the possible evolution of the elements.

and are quite independent of biology in any respect whatsoever. Biology is nevertheless dependent upon them, for life can manifest itself only in active physico-chemical systems. Thus a further and more interesting conclusion arises:—In fundamental characteristics, viz., in the physical and chemical properties of water and carbonic acid and in various other similar respects, the actual environment is the fittest possible abode of life.

To some of my critics this statement not unnaturally seems extravagant.[4] But I hope that this may be due to my failure clearly to explain its meaning and its foundation, rather than to a real fallacy in its development. For in the first place it is to be observed that by fundamental characteristics I mean just those abstract physico-chemical properties like temperature, concentration, stability, chemical activity, etc., which can be measured. And in the second place, I mean not merely a few of such characteristics, but, so far as physical science can recognize them, all such characteristics. Now there can be no doubt that, in respect to these things, water, carbonic acid and the three elements are really unique, and nobody who has examined the evidence has thus far expressed a doubt of it. I need hardly add that I am speaking of the world as we know it and not of any hypothetical world in which matter assumes unknown forms and activities.

The difficulty, then, must lie in what appears to certain biologists, though I think not to the physicists, as an unwarranted assumption. This is that stability, wealth and variety of supply of matter and energy, and mobility thereof, and a host of other similar characteristics, must be an advantage to life in its effort to evolve, and that this is true not merely of life as we know it, but of any possible life manifesting itself in the world as we know it, in this world of our modern astronomy, physics and chemistry. Further, that the greater the magnitude of these characteristics the greater the advantage to life, and hence that, among the compounds and elements which we know, the environment made of water and carbonic acid on a planet's surface is the fittest. Of course I do not mean this planet—this earth—but any planet constituted like those of our universe; for I am dealing abstractly, not specifically, with cosmic evolution.

This difficulty raises the question, which evidently can be but imperfectly answered, what are, speaking generally and abstractly, the relations between any material system and the rest of the world? This, once more, is a purely physico-chemical problem.

As a result of the thermodynamical studies of Willard Gibbs and his development of the phase rule, a large part of modern physical chemistry is concerned with the classification of systems, their activities, and the conditions of equilibrium within them. An aggregate of matter occupying a position of space is a physico-chemical system. In physical chemistry it is customary, for the sake of the simplification, to study closed systems, that is to say, systems which are not exchanging matter or energy with the outside world. But it is quite possible to proceed from these closed systems to such as are exchanging matter and energy with their environment. Now the phase rule has made possible a very complete and exhaustive classification and description of systems in a perfectly abstract way.[5] Necessarily, therefore, it has provided a complete qualitative physical and chemical analysis of the fundamental characteristics of any system.

In addition to its material and spatial characteristics a system must manifest activity. In the very simplest case it will at least exhibit that motion which we call heat. But activity also has been brought completely under the sway of physical science, for energetics deals exhaustively with all forms of physical and chemical activity.

[4] R. S. Lillie, SCIENCE, N. S., XXXVIII., 337, September 5, 1913; J. Arthur Thomson, *Hibbert Journal*, p. 220, October, 1913.

[5] It must be pointed out that there is a certain incompleteness, which happily is of minor importance for our present purpose, in the failure to take account of such a thing as electrical potential.

It seems to be true (one may note in passing) that with the progress of science the term mechanism has come to mean merely any active system. In what follows I shall, therefore, use the word mechanism in this sense. According to this definition the mechanistic explanation of a phenomenon is simply its explanation as the activity of a system, and this is the only explanation known to physical science.

Finally, in addition to its material, spatial, and energetic characteristics a system must also be characterized as a whole and in its parts, in its form, structure, and activity by durability. The consideration as well of time as of activity permits the transition from the statical to the dynamical.

In short, form and size, physical and chemical constitution, activity and duration are the general factors to be considered in any phenomenon whatsoever. In the complete description of any mechanism all must be considered, but, for the purposes of physical science no others need be, or indeed can be, introduced.

It is accordingly possible, without any examination of the results of biology, and even in complete ignorance thereof, to investigate the fitness of the special properties of matter for any mechanism, *i. e.*, for mechanism in general.

THE SYSTEM

The fundamental characteristics of a system are the components, the phases, the concentrations, and further temperature and pressure. Hence fitness for *any* system involves the possibility of the greatest number and variety of components and phases, of the widest ranges of concentrations, temperatures and pressures. It has been shown in "The Fitness of the Environment" that the number of possible components (chemical compounds) consisting of carbon, hydrogen and oxygen is far greater than in the case of other elements; that the meteorological cycle mobilizes on land and sea far greater numbers of other elements than would be the case if water were not the active agent in the process; that an aqueous solution is capable of holding a far greater number of components in far greater concentrations than can any other; that water makes possible, through its unique thermal properties and its unique qualifications in relation to colloids, the greatest possible number and variety of phases. Moreover, many other similar facts have been established without coming upon an unfavorable instance or exception in the course of prolonged search. As for wide ranges of temperature and pressure, they may be passed by, for as a rule such conditions are not consistent with durability, hence their importance is very restricted.

ACTIVITY

Any activity is possible provided a suitable system exists and provided suitable energy is present. This fact leads us back to the conclusion that chemical transformations of hydrogen, oxygen and carbon are the very best chemical means of storing and liberating energy, and that the reactions of organic compounds permit the most delicate adjustments of such transformations. Further it has been shown that the unique thermal properties of water are most highly suited to the storing and distribution of energy, while its solvent power facilitates osmotic pressure and diffusion. It may also be mentioned as a final instance of fitness for activity, among many other examples, that the electro-chemical characteristics of water are in many ways the best possible sources of electrical activity.

DURABILITY

Durability depends upon stability of conditions and upon supplies of matter and energy to replace what is used up.

The stability of physico-chemical conditions, which is due to the presence of water and carbonic acid as primary constituents of the environment, is very great indeed, and, beyond doubt, far greater than what could exist if these substances were replaced by any others. A very large part of all the data of oceanography and meteorology do but illustrate the almost inconceivable efficiency with which water, in the main through its unique thermal properties, completely checks very wide ranges of temperature, and as a rule restricts the

range of temperature within narrow limits in the waters and throughout the earth. Even more exact is the regulation of the alkalinity of the ocean by means of carbonic acid, through its unique solubility and ionizing power. These are but two among many examples of maximal efficiency in regulation.

The renewal of matter and energy are not less highly favored. The properties of water ensure everywhere the highest availability of supplies in the greatest number and concentration. Further the three elements carry with them the possibility of maximal energy supplies. In some respects, indeed, the ubiquity and mobility of water and carbonic acid, their presence in the sea, in the lakes and streams, in the air, and in the soil, which depend upon the combined action of the unique solubility of carbonic acid, the unique vapor tension of water, and its unique surface tension, seem the most remarkable of all fitnesses.

I can not further develop these considerations here, for they are too numerous and too varied, but I have elsewhere treated them extensively.[8] In truth, all the properties of water, of carbonic acid, of the compounds of carbon, hydrogen and oxygen, of the ocean, and of the meteorological process, so far as the present state of science permits their analysis, need to be considered, for each adds to the argument. Each contributes to duration, or to activity, or to the phases, or compounds, or concentrations of possible systems. Each tends to increase rather than to restrict the possibilities of mechanism, and each is the best, or nearly the best, among all the known substances in the world. And the ensemble of these properties is perfectly and extraordinarily unique.

All of these relationships are merely physical, nothing about them is biological except their importance.

From such considerations there can be but one conclusion: the unique ensemble of properties of water, carbonic acid and the three elements constitutes among the properties of matter the fittest ensemble of characteristics for durable mechanism. No other environment, that is to say no environment other than the surface of a planet upon which water and carbonic acid are the primary constituents, could so highly favor the widest range of durability and activity in the widest range of material systems—in systems varying with respect to phases, to components, and to concentrations. This environment is indeed the *fittest*. It has a claim to the use of the superlative based upon quantitative measurement and exhaustive treatment, which is altogether lacking in the case of the fitness of the organism. For the organism, so we fondly hope, is ever becoming more fit. and the law of evolution is the survival of the fitter.

Yet it is only for mechanism in general, and not for any special form of mechanism, whether life as we know it, or a steam engine, that this environment is fittest. The ocean, for example, fits mechanism in general; also, if you will, it fits the whale and the plankton diatom, but not man or a butterfly. But, of course, as everybody has known since 1859, it is really the whale and the diatom which fit the ocean. And this leads to the true conclusion of our investigation.

Just because life must manifest itself in and through mechanism, just because, being in this world, it must inhabit a more or less durable, more or less active physico-chemical system of more or less complexity in its phases, components and concentrations, it is conditioned. The inorganic, such as it is, imposes certain conditions upon the organic. Accordingly, our conclusion is this: *The special characteristics of the inorganic are the fittest for those general characteristics of the organic which the general characteristics of the inorganic impose upon the organic.* This is the one side of reciprocal biological fitness. The other side may be similarly stated: Through adaptation the special characteristics of the organic come to fit the special characteristics of a particular environment, to fit, not any planet, but a little corner of the earth.

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[7] See "The Fitness of the Environment."

THE PITTSBURGH EXPERIMENT STATION OF THE BUREAU OF MINES

Plans for the proposed $500,000 experiment station of the United States Bureau of

Mines to be located in Pittsburgh, Pa., have been approved by the commission appointed by congress for that purpose. The federal government now owns the property upon which will be erected a group of buildings, especially designed and adapted for the carrying on of the mine safety work and other investigations in which the Bureau of Mines is interested.

Congress a year ago, in the public buildings bill, authorized a new home for the Bureau of Mines to cost $500,000. It is now expected that congress in its present session will make a specific appropriation so that construction work may begin. It is hoped that contracts may be let by July 1. The director is hopeful that the buildings may be completed in the fall of 1915, when they will be dedicated with suitable ceremony, including a second National Mine Safety Demonstration, similar to that held at Pittsburgh in 1911.

The commission which has approved the plans consists of J. A. Holmes, D. C. Kingman, chief of engineers of the United States army and O. Wenderoth, supervising architect of the treasury. The state of Pennsylvania has appropriated $25,000 for cooperation in establishing this experiment station and has appointed a state commission consisting of James E. Roderick, chief mine inspector, Dean W. R. Crane, of the mining department, Pennsylvania State College, and W. H. Caverly. This latter commission has tentatively approved the plans.

The buildings which will constitute the experiment station of the bureau will form a part of a most remarkable and unusual group of monumental edifices devoted to educational purposes. On one side the bureau's buildings will face the great group of structures of the Carnegie School of Technology. On another side is the Carnegie Institute, in which are the art gallery, museum and library. Nearby is the imposing pile of buildings of the University of Pittsburgh. Other nearby buildings are the Memorial Hall, Pittsburgh Athletic and University Club and the Hotel Schenley. The site consists of nearly twelve acres of land, part of it on the higher level of the city streets and part of it on the level of the B. & O. Railroad, which railroad will furnish adequate facilities for passengers and freight traffic.

The group consists of three main buildings facing Forbes Street and the several street-car lines from the uptown district. The central building of the group, the mining building, will be three stories in height, flanked by two main buildings, one the mechanical and the other the chemical building. In the rear of these and inclosing a court will be the service building. Beyond the service building and spanning what is known as Panther Hollow and thus connecting the Bureau of Mines buildings with the Carnegie Schools, will be two buildings over the roofs of which will pass the roadway from Forbes Street to the Carnegie School buildings and Schenley Park.

Between the main group and the power and fuel group will be the entrance to a series of mine shafts. One of these will be used as an elevator to carry heavy material and passengers from the lower level to the upper; another will be for tests of hoisting ropes and similar mining appliances; another will be an entrance to tunnels extending under the buildings and in which mining experiments, such as fighting mine fires, will be conducted.

The portion of Panther Hollow above the power buildings will be arranged as a miners' field, the slopes of the ravine being utilized as an ampitheater which will accommodate 20,000 spectators who may assemble here to witness demonstrations and tests in mine rescue and first-aid.

The main or mining building will contain the administrative offices, and those of the mining force. In it will be an assembly and lecture hall, a library and smoke and other rooms for demonstrations and training in mine rescue and first-aid. The mechanical building will be for experiments and tests of mining machinery and appliances and the chemical building for investigation and analyses of fuels, explosives and various mineral substances.

The buildings now used by the Bureau of Mines as an experiment station at Pittsburgh

were loaned to the bureau by the War Department as an emergency measure when the bureau was created. The War Department has suggested that it now needs these buildings and it is felt the bureau can not retain possession much longer. The buildings are very old and are entirely unsuited to the needs of the Bureau of Mines work. It is said that the investigations have been seriously handicapped by the inadequacy of the structures now in use.

THE FUR-SEAL COMMISSION

The President of the United States and the Secretary of Commerce have approved the recommendation of the Commissioner of Fisheries for the appointment of a special fur-seal commission, to visit the Pribilof Islands during the present season for the purpose of advising the government as to the condition of the seal herd and of making recommendations regarding the policy that should be adopted with reference thereto.

The members of the commission, in accordance with the suggestion of the Commissioner of Fisheries, have been selected by outside agencies and have had no previous connection with the fur-seal controversy.

In response to a request that a duly qualified assistant of the Department of Agriculture, versed in the breeding and other habits of wild and domestic animals, be designated to serve as a member of the commission, Mr. Edward A. Preble, assistant biologist of the Bureau of Biological Survey, has been nominated by the Secretary of Agriculture.

The Secretary of the Smithsonian Institution was requested to name, as a second member of the commission, a person duly qualified to make a critical study of the economic relations and obligations of the government toward the fur-seal herd, the natives of the seal islands, and the fur trade. Mr. Wilfred H. Osgood, of the Field Museum of Natural History, Chicago, has been chosen for this purpose.

The President invoked the National Academy of Sciences to nominate as a third member of the commission a person qualified to study the scientific and economic questions involved in the administration of the seal herd; and Dr. George H. Parker, of Harvard University, has been duly nominated.

Arrangements have been made for sending the commissioners to and from the seal islands on a revenue cutter; they will arrive in the latter part of June and will remain until the second week in August, thus covering the most critical periods of the land life of the seals.

SCIENTIFIC NOTES AND NEWS

The spring meeting of the council of the American Association for the Advancement of Science will be held at the Cosmos Club, Washington, D. C., on the afternoon of Tuesday, April 21, at 4:45 o'clock.

At the general meeting of the American Philosophical Society, held at Philadelphia from April 23 to 25, there will be presented to the society a portrait of the late Samuel Pierpont Langley, a former vice-president.

As has already been noted in Science, the American Chemical Society is holding its spring meeting at Cincinnati, Ohio, during the present week. Each of the sections has a full and important program. At the general session on the first day, after addresses of welcome by the mayor of the city and the president of the University of Cincinnati, and a reply by the president of the society, Professor Theodore W. Richards, the following papers were announced: Arthur L. Day, "The Chemical Problems of an Active Volcano"; L. J. Henderson, "The Chemical Fitness of the World for Life"; W. D. Bancroft, "Flame Reactions"; Irving Langmuir, "Chemical Reactions at Low Pressures."

A portrait of Sir William Ramsay, painted by Mr. Mark Milbanke, has been presented to University College, London, by former colleagues and past students. Professor J. Norman Collie made the address. A replica of the portrait has been presented to Lady Ramsay.

Professor John F. Downey, dean of the college of science, literature and the arts, of the University of Minnesota and professor of

mathematics, will retire in June, 1913, after thirty-three years of service as a member of the Minnesota faculty.

The Cambridge University observatory syndicate has appointed Professor A. S. Eddington, Plumian professor of astronomy, to be director of the observatory.

Mr. Arthur Scott, for some years past a teacher of science in Chili, has been appointed assistant in the Lick Observatory, on the D. O. Mills Foundation, for service in the work of the D. O. Mills Southern Hemisphere Expedition, which at Santiago, through the gift of Mr. Ogden Mills, of New York, is carrying on extensive studies in the movement of stars in the line of sight.

We learn from *Nature* that the first award of the Kelvin gold medal and prize, founded by Lady Kelvin at the University of Glasgow for the best dissertation in natural philosophy presented for the degree of D.Sc. during the three years 1911–13, has been made to Dr. A. D. Ross, now professor in the University of Western Australia. The first award of the William Jack prize (founded in honor of Emeritus Professor Jack), for the best dissertation in mathematics presented for the degree of D.Sc. during the four years 1910–1913, has been made to Dr. R. J. T. Bell, senior university lecturer in mathematics.

Professor John Zeleny, head of the department of physics of the University of Minnesota, has been granted a year's leave of absence, which he will spend in private study and research at Cambridge, England. Professor Anthony Zeleny will act as chairman of the departments during the year 1914–15.

Professor Ludwig Pick, of Berlin, will deliver the Harrington lectures of the medical department of the University of Buffalo, under the title of "Some Advances in Pathological Anatomy."

Dr. Lightner Witmer, of the University of Pennsylvania, and Professor L. C. Coffman, of the University of Illinois, were the principal lecturers at a week's conference of principals and superintendents of city schools, held at the University of Minnesota, March 23–28, with a registration of about 300.

The Bakerian Lecture of the Royal Society was delivered by Professor A. Fowler on April 2, on "Series Lines in Spark Spectra."

Dr. Egbert Le Fevre, dean of University and Bellevue Hospital Medical College, New York City, died on March 30, from scarlet fever, aged fifty-five years.

Dr. John Henry Poynting, professor of physics at Birmingham University, has died at the age of sixty-one years.

Professor G. M. Minchin, F.R.S., formerly professor of mathematics, Royal Indian Engineering College, Coopers Hill, died on March 23, at the age of sixty-eight years.

Dr. G. J. Burch, F.R.S., formerly professor of physics at University College, Reading, has died at the age of sixty-two years.

Professor G. Joachimsthal, of Berlin, chief of the university clinic for orthopedic surgery, has died at the age of fifty years.

The London *Times* reports that Sir John Murray, the oceanographer, who was killed in a motor-car accident on March 16, has by his will bequeathed his books, papers, letters, collections, specimens, furniture, fittings, instruments, and such effects in his Challenger Office at the Villa Medusa, Wordie, Edinburgh, as also the books, etc., property belonging to his scientific library in Challenger Lodge at the time of his death, to his son, whom failing, to his daughters, along with a number of shares in the Christmas Island Phosphate Company, in order that the dividends may be applied in scientific research or investigations or explorations which are likely to lead to an increase of natural knowledge, and especially in the science of oceanography. He expressed the wish that his deep-sea collection of marine deposits and scientific library should be kept together and be cared for by his sons or daughters, the Villa Medusa being used for the purpose, so that scientific work might be carried on there for 20 years after his death. It is suggested that in the case of substantial expenditure the Challenger Society or the Royal Society of London or the Royal Society of Edinburgh might be consulted.

To search the Arctic Circle for the lost Canadian exploration ship *Karluk* the steam whaler *Herman* has left San Francisco. The Canadian government is sending the whaler to the relief of the *Karluk,* which with the greater part of her crew has been missing for several months. It will be remembered that Mr. Stefansson, commander of the expedition, who with three of the crew left the *Karluk* which was fast in the ice, to hunt caribou, could find no trace of the vessel when they returned. The ice had been broken up by a gale and the ship, it is supposed, drifted eastward. Captain C. T. Pedersen, master of the *Herman,* believes he will find the *Karluk* somewhere between Point Barrow and Herschall Island, locked among icebergs.

Nature states that while the various official and private expeditions are making preparations for observing the total solar eclipse of August 21 next, steamship companies are offering pleasure cruises which include a stay on the line of totality on the Norwegian coast. The Royal Mail Steam Packet Company's ocean yachting steamer, *Arcadian,* twin screw, and 8,939 gross tonnage, is timed to leave Grimsby on August 15 and Leith, August 16, and will take up a position near Alsten, north of Torghatten Island, well on the central line. The Norway Travel Bureau of the Great Northern Railway Company has also arranged a special cruise. Passengers leave Newcastle-on-Tyne by the steamship *Venus* on August 15, and join the special steamer *Mira* at Bergen on August 17, a position being taken up at Stokka on eclipse day. It is stated that if a party of seventy-five to eighty members of the Royal Astronomical Society and the British Astronomical Association would avail themselves of this facility no other passengers would be accepted, and the itinerary would be varied to meet the requirements of the party, and the stay at any place in the eclipse zone prolonged.

THE Association of Dental Faculties of American Universities met at the University of Minnesota, March 20–21. Dean Owre, of Minnesota, read a paper recommending the adoption by this association of a four-year course in dentistry for all the colleges composing the association. This recommendation was adopted. The deans present at the meeting were: Frank T. Breene, Iowa State College; Edward C. Kirk, University of Pennsylvania; James Sharp, University of California; F. B. Moorehead, University of Illinois, and W. S. C. Hoff, University of Michigan. In addition there were present several members of the faculties of the institutions represented. The dental college of Washington University, St. Louis, Dr. J. H. Kemmerly, delegate, was admitted to membership.

WORK is now in progress at the University of Chicago on a building for the Departments of Geology and Geography to be known as the Julius Rosenwald Hall. It will be made of stone, steel and cement and be fireproof in the best sense of the term. The cost will be about $260,000, exclusive of the furniture and equipment. It adjoins Walker Museum and will be connected with it by corridors on each floor. Both buildings will be served by an elevator in the corridor connection. As the plans have been carefully drawn on the basis of large experience, the following list of the appointments may be of interest to geologists and geographers: A museum room, an assembly hall, six class rooms, a seminar room, laboratories for mineralogy, petrology, economic geology, geo-chemistry, macroscopic determination, ore genesis, high temperature and high pressure experiments (outside the main walls of the building), physiographic modeling, dynamical and structural experimentation, lathe and section work, and miscellaneous work, a laboratory-conference room, a seismograph room (with pier carried down to solid rock by caisson), a vault for documents and rare material, three map laboratories with three associated map-conference rooms, a general departmental reading room with accommodations for eighty, a stack room for departmental library with capacity for 66,000 books, with book-lift, and a library work room; a research reading room, five research study-rooms for staff, a staff research room each for geology and for geography, ten research rooms for candidates for Ph.D., a council room, nine

offices for staff, a stenographer's room, a waiting room, a meteorological tower, with a laboratory, a work room and an office, three dark rooms, a goniometer room, a microphotographic room, a room for liquid separation of minerals, five storage rooms, five storage closets connected with class rooms, cloak rooms, lockers and four toilet rooms. The ventilation will be forced by an electric fan in the basement supported by a suction fan near the roof. The exterior of the building will be ornamented with symbolic bas-reliefs representing subjects appropriate to the earth sciences, as well as some of the great leaders in special phases of the science. The contract calls for the completion of the building by the first of November. The paleontologic work will remain in Walker Museum and the two buildings will be used in close relationship.

THE water supply of the great Missouri River drainage area is the subject of a publication recently issued by the United States Geological Survey, entitled "Surface Water Supply of the Missouri River Basin, 1911," by W. A. Lamb, W. B. Freeman and Raymond Richards. This report contains the records of flow at 130 permanent stations of the survey during the year 1911, data which are necessary to every form of water development, whether it be water power, navigation, irrigation or domestic water supply. Some of the tributary streams are exceedingly variable in flow; others, like the Niobrara in Nebraska, are remarkably uniform. A systematic study of Missouri River and its tributaries is being carried on by the United States Geological Survey. Considering the varied character of the streams of the Missouri River basin and their great economic importance for irrigation, power and other purposes, the investigation is one of importance. The Missouri proper is formed in southwestern Montana by the junction of three streams which were discovered by Lewis and Clark in 1806 and were named by them Jefferson, Madison and Gallatin Rivers. Of these three Jefferson River drains the largest area and is considered the continuation of the main stream. This part of Montana is mountainous and affords many excellent water-power sites. Among the principal tributaries of the Missouri are the Marias, Musselshell, Yellowstone, Cheyenne, Platte and Kansas. The western part of the basin is in the arid belt and the eastern part is in the semiarid and humid regions. Ten states are drained in part by Missouri River. Rising at the Red Rock Lakes, at an elevation of 6,700 feet above sea level, this stream descends through the Rocky Mountains and emerges on the broad prairie land a few miles below the city of Great Falls, Mont. From that point it is accounted a navigable stream with an easy grade, and in passing through the Dakotas and along the borders of Nebraska, Kansas and Iowa it receives the flow of great tributaries, so that as it crosses the State of Missouri and joins the Mississippi a short distance above St. Louis, it becomes one of the large rivers of the world. Its total drainage area is about 492,000 square miles in extent and comprises, in addition to the states above mentioned, large areas in Wyoming and Colorado and a smaller area in the southwestern part of Minnesota. On Shoshone River in Wyoming, a tributary of the Bighorn, which in turn is tributary to the Yellowstone, which joins the Missouri in eastern Montana, is located the Shoshone dam, the highest structure of its kind in the world, 328 feet from foundation to capstone. This structure was erected by the government to impound water for irrigation on the arid lands in the valley of Shoshone River below. Another great structure of a similar kind is located in Wyoming on North Platte River, which joins the Missouri near Omaha, Nebr. This is known as the Pathfinder dam, and was also erected by the government to impound water for use in the irrigation of lands in Wyoming and Nebraska. Another notable engineering structure in the drainage basin of the Missouri River is the Belle Fourche dam, erected across the river of the same name in South Dakota by the government to impound water for irrigation. This dam is an earth embankment 155 feet high and one and one fifth miles long, containing 1,600,000 cubic yards of earth fill. This is the largest earth dam in existence.

UNIVERSITY AND EDUCATIONAL NEWS

A CONTRIBUTION of $50,000 from Mrs. E. H. Harriman to the endowment fund of Barnard College, Columbia University, is announced toward the million dollar fund now being raised for the twenty-fifth anniversary of the institution $550,000 is now pledged.

DR. J. B. JOHNSTON, professor of neurology in the department of anatomy of the University of Minnesota, has been appointed professor in the department of animal biology in the College of Science, Literature and the Arts, and dean of that college from August 1, 1914.

RICHARD LABAN ADAMS, a graduate of Massachusetts Agricultural College and M.S. of the University of California, has been appointed assistant professor of agronomy in the University of California. James Alexander Armstrong, a graduate of 1910 of the University of California, and now chief chemist of the Union Sugar Company at Betteravia, California, has been appointed field assistant in agricultural extension in the university.

DR. E. G. KENNARD, of Cornell University, has been appointed instructor in physics at the University of Minnesota.

MR. A. V. HILL has been appointed to the Humphrey Owen Jones lectureship in physical chemistry, at the University of Cambridge.

DISCUSSION AND CORRESPONDENCE

GYROSCOPIC QUANTA

IN the note[1] on gravitationally produced vortices in the ether and their relation to Planck's quantum theory, attention should perhaps have been called to some additional deductions.

For example, that it necessarily follows from the writer's electrostatic-doublet vortex theory of matter,[2] that the energy radiated when a distortional ether wave strikes an atom will be given off in quanta and be proportional to the frequency.

The simplest way of seeing this is to take the well-known experiment in which a gyroscope is held in the hand and the body revolved first in one direction and then in the other. On turning the body in one direction no effect is produced on the gyroscope. On turning in the other direction the gyroscope resists and is upset, and the axis then points in the opposite direction.

It may easily be shown that the amount of work done in upsetting the gyroscope varies directly as the angular velocity of rotation of the body, *i. e.*, in the case of the atom and ether wave, is directly proportional to the frequency.

It will be seen that this type of atom is somewhat different from any of those heretofore proposed. For example, instead of the electrons being numerically equal to one half the atomic weight the electrons can be numerically equal to the atomic weight, but only one half of them affected by any given ether displacement.

In addition, the stable equilibrium conditions of this type of atom are comparatively simple and the positive nucleus may be made to vanish, *i. e.*, can be formed of a number of negative electrons as pointed out in a previous paper.

REGINALD A. FESSENDEN

BROOKLINE, MASS.,
March 1, 1914

[1] SCIENCE, October 17, 1913.

[2] See papers referred to 1889–1900 in previous note.

MULTIPLE FACTORS IN HUMAN SKIN COLOR

A RECENT article by E. C. MacDowell[1] on "Multiple Factors in Mendelian Inheritance" is highly significant in its explanation of cases of apparently "blended" inheritance. The author gives a clear historical summary of experiments made by various investigators, beginning with Nilsson-Ehle's studies on oats and wheat first published in 1909. The original work reported is upon sizes in rabbit hybrids. It is a continuation of Castle's well-

[1] *Jour. Exper. Zoology*, Vol. XVI., No. 2, pp. 177–194, 1914.

known studies and was carried out with Castle's own material and with his cooperation and help. The experiments now reported show that the Nilsson-Ehle explanation of "blended" inheritance (*i. e.,* two or more non-allelomorphic factors producing phenotypically similar phenomena) may be applied to size differences in hybrid rabbits.

The fact that crosses between negroes and whites give mulattoes has long been pointed to as proof of "blending." But, as is well known, various pigments are here involved, viz., black, red and yellow. Davenport[2] has shown clearly that the children of two mulatto parents exhibit great variation in color. Occasionally some are light enough to "pass for whites" when away from home. The explanation of this phenomenon, as based on multiple factors, is suggested by Davenport. In the light of MacDowell's own work and the work that he cites there can be little doubt of the correctness of this view. Probably there are separate factors (determiners) for the several pigments and more than one, perhaps many, for the black pigment.

A quotation from MacDowell's paper shows the conclusions drawn from his studies of rabbits. But his statements may be applied to human skin color and, no doubt, to many heritable characters of human beings:

> Offspring from crosses between extremes are generally of an intermediate nature. In the following generation new forms appear that are similar to the original parents or even more extreme. The greater number of individuals are intermediate. In certain cases crosses between similar lines, after a first generation like the parents, give a second generation in which a wide range of grades appear. These are the facts definitely ascertained from the work that has been done. . . . The interpretation of multiple factors can be applied to all the facts. It goes hand in hand with the mutation and pure-line doctrines of de Vries and Johannsen, and in its breadth of application, and its comprehensive simplicity, this theory, based on the assumption of the segregation of distinct units, is very attractive; by its use as a working hypothesis important facts have been discovered; its acceptance and further development will help to establish a broad and unified system of heredity.

[2] "Heredity in Relation to Eugenics," pp. 36–38, New York, 1911.

Doubtless many "well-informed" persons still hold to the idea of "blended" inheritance. It is with the hope of calling attention to the Mendelian phenomena involved that this note is submitted. A careful reading of MacDowell's article will clear up many puzzling difficulties for those who are interested in heredity but have not kept up with the literature of the past few years.

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DIADOPHIS PUNCTATA IN NORTHERN WISCONSIN

RUTHVEN[1] has recorded the occurrence of the ring-necked snake, *Diadophis punctata* (Linnæus), at Marquette, Michigan, on the strength of specimens having "been taken by Dr. Downing," but later the same authority states: "The Marquette record is particularly open to question and has not been recorded upon the map."[2] Not having seen a specimen from Marquette, Ruthven was perfectly justified in making his later statement, in view of the fact that the locality was considerably beyond the known northern geographic range of the species. It may be interesting, however, in this connection to note that on July 5, 1912, I collected a specimen of this species near Rhinelander, Oneida county, Wisconsin, a locality about 120 miles west-southwest of Marquette, Michigan. The snake was found, one and one half hours after sunset, extended full length across the wheel tracks of a sandy road bordering low second-growth woods of *Pinus divaricata, Betula papyrifera, Populus tremuloides* and *Quercus coccinea;* in the late twilight the animal was scarcely visible from the wagon in which I was driving. It made no resistance to being captured, was perfectly docile, and soon became tame. It showed a tendency towards positive reaction to contact

[1] Ruthven, A. G., 1906, Report Geol. Surv. Michigan for 1905, p. 111.

[2] Ruthven, A. G., Thompson, C. and Thompson, H., 1912, "The Herpetology of Michigan," Michigan Geol. and Biol. Surv., publ. 10, p. 107.

stimuli and a negative reaction to strong light, factors which may, in part, determine the nocturnal and hiding habits of this species. Unfortunately I was not favorably situated at the time for an extensive study of the habits and behavior of the animal, and it was, therefore, the next day preserved as a specimen.

On account of the rarity of this species in the northern part of its geographic range it seems that a brief description of this specimen is not amiss. The general color of the back can best be described as dark bluish olive-brown; the ventral parts, labials and neck-band (two scales wide) are salmon pink, being slightly darker postero-ventrally and sightly more yellowish on the supralabials and neck-band; a series of about 40 small black spots are scattered irregularly in a single midventral line from the 41st to the 144th ventral plates, being more numerous between the 86th and 144th ventral plates. The total length is 335 mm.; tail, 80 mm. The scutellation is as follows: dorsal scale rows, 15; ventrals, 156; subcaudals, 53; supralabials, 8-8; infralabials, 8-7; oculars, 2-2; temporals, 1-1.

Hartley H. T. Jackson
U. S. Department Agriculture

SCIENTIFIC INSTITUTIONS MINUS SCIENCE

In recent years the question has much occupied the public mind whether fraternities in schools and colleges are desirable or not. Those who favor the negative, often point to the low scholarship of the members of fraternities. The fraternities have reacted by strenuous efforts to raise the scholarship among their members. One of the national organizations recently offered a loving cup to that chapter in a group of universities of the Middle West which would make during the year the highest scholarship record. The national officers asked two members of the faculty of the University of Missouri to select the chapter. That ought to be easy. But it was found impossible. To make such an award, it is not sufficient to know that each chapter got so many A's, B's etc., or so many 95's, 90's, etc., whatever the symbols may be in each institution. It is absolutely necessary to know the frequencies of these grades in the whole student body of the institution. But none of these institutions, except one, could furnish these data, although, without the frequencies being known, their grades are practically meaningless. Here, then, we have institutions which are generally regarded as the representatives of science. But to apply science to the grades, of which they record year after year thousands, and without which they appear to be unable to get along, that does not seem to have occurred to the administrations of most of them. Their alumni look with amazement upon their *alma maters* which can not furnish the data for the solution of so simple and so proper a problem as that of awarding a loving cup to a group of students who have distinguished themselves by their scholarship.

Max Meyer
University of Missouri

THE LANGUAGE OF THE BRAZILIAN PEOPLE

To the Editor of Science: Regarding the review of the work entitled "Fosseis Devonianos Do Paraná," published in the March 13 issue of Science by Dr. Chas. K. Swartz, Baltimore, Md., in the last paragraph where it mentions the work done by Dr. John M. Clarke, for the Department of Agriculture, Commerce and Industry (Geological and Mineralogical), I find a mistake in his stating that the work is published in the English and Spanish languages in parallel columns. Mr. Swartz should have said that it is published in Portuguese and English, the former being the universal language of the Brazilian people.

E. Braga

QUOTATIONS

PROFESSORS IN COUNCIL

In the circular letter that was sent out in the spring of 1913, looking to the formation of a national association of university professors, the motive actuating the signers was indicated in the statement that, besides his interest in his specialty, the university professor is "concerned, as a member of the legis-

lative body of his local institution, with many questions of educational policy which are of more than local significance"; also that "he is a member of a professional body which is the special custodian of certain ideals, and the organ for the performance of certain functions essential to the well-being of society." And the general purposes were declared to be "to promote a more general and methodical discussion of the educational problems of the university; to create means for the authoritative expression of the public opinion of the profession; and to make possible collective action, on occasions when such action seems called for." The letter was sent out by Johns Hopkins professors to members of the faculties of nine other universities, and the response was favorable in all cases; a conference on the subject was held last November; and now announcement is made of the names of a committee, representing the chief departments of learning and nearly all the leading universities of the country, whose task it will be to take the steps necessary for complete organization.

The distinctive feature of the American university is the part played by the president. Nothing even distantly resembling it exists, we believe, in any European country. That he is not the absolute monarch he is sometimes represented as being is true enough; but the limitations upon his power are often of the same nature as those which have as a general rule obtained in the case of what are usually designated as absolute monarchies in the history of nations. No university president thinks of setting up his personal will as the sole guide of his policy. Apart altogether from such check as may be exercised by the board of trustees, or other formal governing body, he usually consults the chief professors in any matter relating to their respective departments; and moreover there exists in every university some form or other of faculty organization. Nevertheless, the president, in most American universities, is the center of power, the chief fountain of favor and disfavor, of advancement or retardation; and his disposition towards any question, whether relating to an individual or to a principle or a policy, usually has, or may have if he chooses, the controlling influence in its determination.

This feature of the American university system has been the subject of endless comment; but there exists alongside it, and somewhat resembling it in nature and effect, another feature that has attracted less notice. What goes on within any university is, in a certain sense, its own private affair; and it may easily happen that it is not the president, but one or more professors or professorial cliques, in whom real power rests, and by whom it is improperly exercised. Now there has not been developed in our country either any central organ—such as the Ministry of Public Instruction in European countries, for example—or any well-defined body of university tradition, to operate as a check upon any bad tendencies or unjust practises which may thus develop in any given institution. When such a state of things arises, whether the blame for it belongs to president or to professors, all that is apt to happen is a certain amount of grumbling, perhaps of indignation; it is only in extreme cases that there is likely to be any overt action. It may be that some professor is the victim of downright persecution; it may be that manageable mediocrity is systematically preferred to high ability which is somewhat more difficult to handle; it may be that independence of thought or freedom of speech is frowned upon and discouraged. Whatever the trouble may be, appeal is impossible to any but the little circle within the university itself, which is to all intents and purposes a close corporation.

That the new association may supply to the American university professor a basis for a wider and more catholic appeal in questions of moment, that it may become the means of promoting a professional spirit at once finer and stronger than that which has hitherto been general, must be the hope of all who are interested in the most truly distinctive service which universities render to a nation. Upon their immediate promotion of the general welfare, not only through the diffusion of intelligence and the improvement of education, but

also through efforts expressly directed to economic and social ends, emphasis has been laid in these latter days as never before. This tendency is bound to continue; and the benefits that will flow from our universities in these ways are quite beyond calculation. But it is not difficult to imagine these results obtained by other instrumentalities, if the institution we call the university were not historically in existence, and ready to furnish them. The thing that the university alone can supply—the thing, at all events, for which neither history nor imagination suggests a possible substitute—is the preservation of high intellectual ideals, the maintenance of noble traditions of science and learning. Of these ideals and traditions university presidents, however masterful, university administrators, however efficient, can not possibly serve as the custodians. It is upon the men whose business is not to administer but to teach and to learn, not to manage but to investigate and to inspire, that we must depend for the keeping alive of the sacred fire. And if we read aright the announcement of its purposes, it is to the strengthening of this conception of the professor's status that the new association is above all to be devoted.—New York *Evening Post*.

SCIENTIFIC BOOKS

The Scientific Work of Morris Loeb. Edited by Theodore W. Richards. Harvard University Press. 1913.

The many friends of Dr. Morris Loeb will feel very grateful to Professor Theodore W. Richards for arranging this volume. It is the best monument yet erected to the memory of a man whose life was an inspiration to all who knew him.

The first part of the volume is a collection of some lectures and addresses referring to chemical research, the Chemists' Club building, the chemical museum and kindred subjects. The great idealism of Dr. Morris Loeb, combined with his practical, well-organized methods and conceptions, are well illustrated by some passages:

Pages 95–96: ". . . How, then, can the status of the independent commercial chemist be raised in our city? By giving him a central rally-point; a home that proves to the layman that his is a skilled profession, not a mere job-hunting trade; a place where the manufacturer or merchant can find the man he wants without a rambling search through the city directory. Doubtless, some of our colleagues are so well known that all the business comes to them which they can handle. But the many additional independent chemists, whom our commercial situation demands, can only establish themselves if they can secure proper laboratory facilities, without hiring attics in tumble-down rookeries. . . ."

Page 96: ". . . Every year scores of New Yorkers graduate in chemistry from our local institutions and return from years of protracted study in other American and European institutions. They are enthusiastic for research; in completing their theses they have laid aside definite ideas for subsequent experimentation; but they have no laboratory. While waiting to hear from the teachers' agency where they have registered, while carrying on desultory correspondence with manufacturers who *may* give them a chance, they do not venture upon expenditure of time and money to fit out a private laboratory, which they may be called upon to quit any minute upon the appearance of that desired appointment. Often necessity or tedium will cause them to accept temporary work of an entirely different character and indefinitely postpone the execution of the experiments which they had mapped out. Who will estimate the loss of scientific momentum, the economic and intellectual waste, which this lack of laboratory facilities for the graduate inflicts upon New York, as compared with Berlin, Vienna, Paris and London? Either our universities and colleges, or private enterprise, should provide temporary desk-room for the independent research chemist."

Pages 98–99–100: ". . . There is still another point, however, in which the American chemist is at a great disadvantage as compared with the European; the ease of securing material for his research and of comparing his

results with those of others. In Europe, especially in Germany, research is never seriously delayed by lack of a needed preparation, whereas, none of our supply houses carry a full stock of chemicals. To obtain a single gram of some particular substance, needed for a few preliminary tests, frequently causes weeks of delay, as well as the disproportionate custom house and brokerage expenses involved in the importation of small quantities. Besides, owing to the better centralization of scientific laboratories in Europe, and the existence in each case of a fairly complete set of specimens accumulated in the researches of large numbers of academic investigators, it is comparatively easy to obtain by correspondence research material or typical specimens for comparison. In this country, on the other hand, laboratories are scattered throughout the numerous colleges and universities, and there are no established rules by which specimens must be deposited with the laboratory. In smaller laboratories, especially, the chances of preservation after the departure of the investigator are not very good. It would be, consequently, very much more difficult to obtain such specimens here. I would suggest, therefore, that a chemical museum be established in New York, to perform for the American chemists the functions that the Smithsonian Institution so admirably carries on for the benefit of American naturalists. This museum would not attempt to be a popular show-place, but would embody, in the first place, as complete a collection as possible of chemically pure materials of the rarer kinds, so as to supplement, but not in any manner compete with, the stock of commercial supply-houses. Any scientific investigator would be entitled to borrow or purchase material required for immediate experimentation, and all used articles would be replaced as quickly as possible.

In the second place, it would be a depository for specimens of new substances obtained in American research. Every chemist would be invited to send to the museum a small quantity of each substance newly prepared by him, not, indeed, as an evidence of the good faith of his investigation, but, rather, to enable future workers to obtain such material, either for comparison, or for further experimentation with the least possible delay. Many substances that are now carried away from universities by students who subsequently abandon chemical research, or which belong to the families of deceased chemists who do not know what to do with them, would thereby be rescued from oblivion, and might ultimately become of the greatest value for a special purpose.

Thirdly, this museum would invite chemical manufacturers to send standard samples of their products, and thereby facilitate the commercial relations between consumer and manufacturer.

To such a museum there could be attached a competent staff of workers for the preparation of samples not otherwise available. In the analysis of samples submitted as official standards, we should have the beginning of that Chemische Reichsanstalt which is now the chief object to which German chemists are directing their attention."

Page 126: ". . . We have detailed some of the more striking advantages which the new building is expected to confer upon the chemical profession as a whole, as well as upon its individual votaries; is it an exaggeration to characterize the constitution of the Chemists' Building Company itself as a new era in the chemical industry of our country? In scanning the list of shareholders, we find representatives of nearly every important concern, or even the larger companies themselves; but that this is not a 'trust,' in the sense so obnoxious to the yellow journalist, is demonstrated by the conditions of the partnership. No shareholder can receive more than 3 per cent. dividends, and the surplus can not, under any circumstances, accrue to his benefit within the next fifty years. This association, therefore, is not for individual profit, but for the raising of the standards of chemical industry and research in the United States. If we recognize what the Verein zur Hebung der chemischen Industrie, founded by Hofmann and Werner Siemens, has done for

Germany, we may well hope for further fruits of this initiative here. Perhaps this building will house joint laboratories for the solution of questions affecting all manufactures alike; or experimental stations for the study of natural products not yet utilized; or a cooperative bureau of standardization for analytical methods; or a national welfare bureau for employees in chemical factories. This building does not owe its erection to some benevolent demigod, extending his protecting wing over people unable to care for themselves; it is a building by the chemists, of the chemists, and for the chemists. May it ever serve as an exemplar of unselfish patriotic cooperation!"

Pages 128–129: ". . . For, strange as it may seem to the layman, who has seen the ugliest blots on a landscape designated as chemical factories, who has sniffed with disgust a chemical odor, has been urged to believe that the chemist's shadow contaminates pure foods, and has been taught in school that alchemy spelled fraud and sorcery, our science is one calculated to develop the ideal side of human nature, and the chemist, more perhaps than the votary of natural science or the devotee of the so-called humanities, is led to an intense interest in human development. . . ."

Page 129: ". . . Our science aspires not only to know, but also to do. On the one hand, it leads us to delve into the secrets of nature, in the minute atom as well as in the far distant stars, in the living cell as well as in the crystallized relics of the convulsions from which this earth was born; on the other, it leads us to apply this knowledge to the immediate needs of man, be it in safeguarding his health, in ministering to his material or esthetic wants, or in regulating his commerce and in facilitating his utilization of the earth's resources. . . ."

". . . There are two ways of aiding a man or a cause: by addition to the income or reduction of the expense. The pecuniary result to the beneficiary may be the same, but the moral one is far different; it is not only the beggar who is pauperized by the cash gift and uplifted by the aid which enables him to earn his own livelihood. Arts and sciences may be stimulated by prizes and scholarships beyond a doubt, but the relation between donor and recipient is not free from restraint and the probability of human error in the selection of the right incumbent makes the method a wasteful one at best. . ."

Part I. contains also his lectures on the "Fundamental Ideas of Physical Chemistry," "Osmotic Pressure," "Electrolytic Dissociation," "Atoms and Molecules," "Hypothesis of Radiant Matter," all models of clear exposition of difficult subjects.

The 170 pages of the second part of the volume relate exclusively to original experimental investigations carried out by Morris Loeb since 1885. His latest contribution "Studies in the Speed of Reductions" was read by him at the International Congress of Chemistry in 1912, a few days before his untimely death, which took him away in the prime of life, from his family and his many friends.

L. H. BAEKELAND

YONKERS, N. Y.

Curious Lore of Precious Stones. By GEORGE FREDERICK KUNZ. Philadelphia and London, J. B. Lippincott Company. 1913. Pp. xiv + 406. Six color plates, 22 double tones and 24 line cuts.

The object of this book, as stated in the preface, is to "indicate and illustrate the various ways in which precious stones have been used at different times and among different peoples, and more especially to explain some of the curious ideas and fancies which have gathered around them. Many of these ideas may seem strange to us now, and yet when we analyze them we find they have their roots either in some intrinsic quality of the stones or else in an instinctive appreciation of their symbolic significance. Through manifold transformations this symbolism has persisted to the present day."

To the interesting task thus outlined Dr. Kunz has brought a lifelong familiarity with gems, knowledge gained by the formation of several collections illustrating the folk-lore of precious stones and the possession of what is

on this subject probably the most comprehensive library in the world. That Dr. Kunz treats the subject sympathetically is to be expected; that he will lead others to similarly regard it is a probable and desirable result of his book. Whoever thinks that superstition is dead among civilized peoples and that only in an age of darkness could a belief in the powers of such insensate bits of matter as gems gain credence, should read the chapter on "Ominous and Luminous Stones" and learn how the innocent and charming opal, regarded entirely without prejudice in the sixteenth century, came, in the nineteenth century, to be invested with fear and dread. All jewelers know that the superstition regarding the opal at the present day seriously interferes with its sale even among the most enlightened. Dr. Kunz evidently would not desire to perpetuate superstitions regarding precious stones, but that they should be invested with sentiment he approves. Thus in the chapter in birthstones (a subject which he treats exhaustively) he says:

"Sentiment, true sentiment, is one of the best things in human nature. While if darkened by fear it may lead to pessimism, with all the evils which such a state of mind implies, if illumined by hope it gives to humanity a brighter forecast of the future, an optimism that helps people over difficult passages in their lives. Thus, sentiment must not be neglected, and nothing is more likely to destroy it than the conviction that it is being constantly exploited for purposes of commercialism. For this reason, the interest as well as the inclination of all who are concerned in this question of birthstones should induce a very careful handling of the subject."

And again,

"Sentiment may best be expressed as the feeling of one who, on a warm summer's day, is rowing along a shady brook or resting in some sylvan dell, with nothing to interfere with his tranquil mood and nothing to spur him on to action; thus he has only suggestions of hope and indulges in rosy views of life. Reality, on the other hand, may be likened to a crisp winter's morning when one is filled with exhilaration, conscious of the tingle of the cold, but comfortable in the knowledge of wearing a tightly buttoned garment which will afford protection should the elements become disturbing. Superstition, lastly, may be said to resemble a dark, cold, misty night, when the moon is throwing malevolent shadows which are weird and distorted, while the cold seems to seize one by the throat and arouse a passionate desire to free one's self from its grip in some way, to change a horrible nightmare into a pleasant dream."

It is probable that it is in the explanations which he gives of the causes of the "curious ideas and fancies" which have gathered around precious stones that Dr. Kunz makes his most important contribution to the subject of his book. So far as the present writer is aware, this has never been attempted before so carefully, or at least with so keen a sense of the mutual relations of the various factors involved. Thus the results of crystal gazing are shown to be due to hypnotism; fancy for birthstones to tradition; the powers of colored stones to color effects, and so on. Besides those already mentioned, some of the subdivisions of the subject treated are, "Talismans and Amulets," "Engraved and Carved Gems" and "The Therapeutic Use of Precious Stones."

As a compendium of the virtues and powers ascribed to precious stones, this work is probably not entirely exhaustive, but it is not meant by this statement to imply that the book is not comprehensive. An exhaustive catalogue of the various attributes of precious stones would probably lack the readableness with which Dr. Kunz has succeeded in investing his work in a remarkable degree. In typography and illustrations the book exhibits the sumptuousness which has always marked Dr. Kunz's works. Some further indication than is given of the size of the objects represented in the plates might be desirable and one could wish more of the jewels to have been represented in color. These are, however, but slight shortcomings in a book which can hardly fail in any part

to interest the student of precious stones and of mind.

OLIVER C. FARRINGTON

The Anarchist Ideal and Other Essays. By R. M. WENLEY.

This contribution of Professor Wenley's must be accepted as it is offered, as a record of varied interests. The topics considered, which in part appeal to the man of science, are various. The essay which gives the name to the volume is entirely retrospective in its view and supplies a parallel in Greek life for the independence of thought and the revolt from established conventions, of which theoretical position the anarchist is a practical and an extreme expression; it is a study of the intellectual sources of the anarchist position. Its value consists in broadening the historical aspect of movements which in their modern setting are overshadowed by local situations. Similarly retrospective is the essay upon "Plutarch and His Age." The central position in the volume is given to a review of the early movement towards physiological psychology. This is an able presentation of the philosophical positions which preceded and guided the formation of psychology as a scientific pursuit. The complex origins are traceable primarily to German philosophers as well as to such men as Weber, Fechner, Lotze, Helmholtz and Wundt, whose philosophical interest was joined to their more rigidly scientific investigations. It is Professor Wenley's purpose to supply not a narrative of the contributions of these men, but rather an interpretation of the intellectual movement which guided them towards the consummation to which they severally but differently contributed. On the whole the two educational essays, the one on "Heredity and Education" and the other on the "University in the United States," give ampler opportunity for Professor Wenley's individuality of thought and for the display of the temper of his opinions. By long residence a member of the professorial guild in this country, yet by training and tradition equally at home in the intellectual perspective of English and Scottish universities, he is in a peculiarly favorable position to perform the functions of comparative criticism which he judiciously exercises. Considerate alike of the inevitable shortcomings of educational provisions in the pioneering stage and of the success which has attended them, he retains the fundamental critical attitude in view of old-world standards; he retains also the rare gift of seeing things as they are, despite the enveloping fog which optimism so commonly breeds. The chief note of his complaint is the neglect of individuality and the lack of professional opportunity within academic life for the man of parts, whose development does not conform to the conventional channels of preferment. In a like sympathetic spirit he attempts to portray for English readers some of the peculiar problems which beset American universities, and does so with remarkable success. From beginning to end the volume is characterized by a directness of statement and an insight into relations which gives the whole a higher value than the seemingly casual treatment suggests.

JOSEPH JASTROW

THE PHYLOGENETIC RELATIONSHIPS OF THE OYSTERS

DR. JAWORSKI, of Bonn, has given in the "Zeitschrift für Induktive Abstammungs- und Vererbungslehre" an interesting discussion of the phylogenetic relationships of the oysters. The material upon which he bases his new *Ostrea* genealogy was collected in the middle Jurassic (Dogger) of northern Peru.

Jaworski's theory is based on the discovery of a new ostreid in the Peruvian Jurassic of considerable dimensions—approximately those of a large *Ostrea virginica,* though much more massive—characterized by (1) incurved and strongly gyrate umbones (those of *Ostrea sensu stricto* are approximately straight); (2) by a broad and greatly elevated hinge area (that of *Ostrea* is moderately low, and either broad or narrow); (3) by a ligament partly internal and partly external, located in large measure behind the beaks and produced beyond the hinge area proper (that of *Ostrea* is wholly

internal, medial in position, and confined strictly within the hinge area); (4) by the presence of an anterior adductor muscle impression indicating the persistence of the anterior adductor in the adult stage (in *Ostrea,* the anterior muscle has been observed by a number of embryologists in larval forms though never in stages later than the nepionic); (5) by the presence of pedal impressions indicating a well-defined, though probably reduced foot (in *Ostrea,* the locomotor organ is the velum which persists throughout the free swimming stage, and the presence of a well-defined foot and byssus have never been established even in the embryo).

These observations have led Jaworski to the theory that the new form, the *Heterostrea steinmanni* Jaworski, represents the mid-Jurassic ancestral type from which the true oysters of the Cretaceous, Tertiary, and Recent were directly derived. In order to establish this new hypothesis, it is necessary to first overthrow some of the critical work that has already been done along this line and from which quite different conclusions have been drawn. The three most notable researches are those made by Jackson, of Harvard, Douvillé, of the French Geological Survey, and Steinmann, of Bonn. Jackson's work was done at the Museum of Comparative Zoology, and his approach to the problem was by way of the embryology of the oyster and a number of closely related mono- and heteromyarian groups. The oysters were watched through all stages of development of the egg, the spat encouraged to attach themselves to transparent media and the growth phenomena studied under magnification. He was thus able to confirm and elaborate many of the observations of Huxley, Horst and Brooks, notably those on the number and position of the adductor muscles during the earlier development of the form.

Ostrea, like all other pelecypods in which the embryonic development has been carefully worked out, passes through a monomyarian stage in which, curiously enough, the single adductor muscle is anterior in position, although it is not the antecedent of the anterior adductor of the adult. Then there is a short period at the end of the prodissoconch and the beginning of the dissoconch stages in which both the anterior and posterior adductors are present and typically dimyarian in position. About the third day after the animal has become attached, the anterior adductor evanesces, and only the posterior remains. The atrophy of the anterior adductor has been explained by purely mechanical action: in the dimyarian stage, the orientation of the soft parts is similar to that of the typical pelecypod; the mouth is approximately midway between the hinge line and the ventral margin and the antero-posterior axis is approximately parallel to the hinge; as soon as the spat become fixed, there is a shifting of this axis through almost 45 degrees so that the mouth lies close up under the hinge. This change in position brings the anterior adductor so near the hinge that it loses most of its efficiency; there is, therefore, a compensating increase in the size and effectiveness of the posterior adductor which is gradually shifted to a point of vantage near the central portion of the valves.

The character and mode of development of the soft parts, as a whole, have led Jackson to the belief that *Ostrea* is the sessile analogue and the direct descendant of the free swimming *Perna.* The difference in habit would readily explain the unequal valves and the absence of the foot in the one form and the equal valves and well-developed foot in the other. *Perna* is characterized, however, by a series of vertical cartilage grooves while in typical *Ostrea* there is a single trigonal sub-umbonal pit. Jaworski's criticism of Dr. Jackson's theory of the relationships seems pertinent: the very fact that the young of *Perna* possess a single sub-umbonal pit similar to that of *Ostrea* and the adults a series of pits implies a highly specialized type. The similarity of the young of *Ostrea* and *Perna* may very properly be due to descendence along collateral lines from a common aviculoid ancestor, but there is small evidence of any more direct relationship. Jackson considers *Exogyra* and *Gryphæa* derivative forms of *Ostrea* which have become highly modified.

Douvillé, like Jackson, considers the oysters as direct descendants of true aviculoids not from *Perna,* however, but from *Lima.* The sessile aviculoids are cemented, as a rule, by the right valve, while in the oysters it is the left valve that is attached. However, it is probable that Douvillé overvalues the systematic importance of this character, for in the inequivalved Pectens it is sometimes the right valve and sometimes the left which is the more convex. *Lima,* a significant fact to Douvillé, assumes an almost vertical position as indicated by the approximately equal valves and the presence in both of a byssal opening. Furthermore, the characters of the ligament are similar in the Ostreas and the Limas. The *Ostrea,* however, does not apparently attach itself by a byssus at any stage in its development. Jackson watched very carefully for such a phenomenon, but was unable to find any trace of it. On the contrary, the spat appear to attach themselves at the very beginning of cementation by the margin of the reflected mantle. If the Ostreids were the direct descendants of *Lima,* as Douvillé believes, they would probably reveal to a skilled embryologist such as Jackson some clue to the presence of a former attachment.

Two major groups of Ostreids have been established by Douvillé: in the one, he has assembled all the dominantly smooth forms, in the other, all the dominantly plicate. In both groups, he finds forms with straight umbones and those with gyrate beaks, and the outline of the species is, in his opinion, directly associated with the environment. Thus, the straight-beaked *Pycnodonta* is characteristic of deep and quiet waters, while forms with strongly twisted umbones, such as *Exogyra,* are developed in the more shallow waters, where there are strong currents to be resisted. If this theory be accepted, it is difficult to account for the frequent association of *Pycnodonta* and *Exogyra* in considerable numbers in the same marl bank. In his correlation also of the sculpture of the plicate group with their environment, his theories seem unwarranted by the facts. It is true, to be sure, that, as a rule, the right valve of the Ostreids is less vigorously sculptured than the left, but there is no evidence that the sculpture evanesces more rapidly in the littoral forms. On the contrary, a strong ribbing is most frequently developed where the need for resistance is greatest.

Douvillé as well as Jackson considers the *Gryphæas, Pycnodontas* and *Exogyras* as derivatives of the true oysters. Jaworski does not admit, however, that the Ostreids of the Triassic which have served as the theoretical ancestral types are true oysters. Steinmann traces the ancestors of the group even back of the Mesozoic and considers *Eurydesma* of the Permo-Carboniferous of Australia and India as the true ancestor of the Ostreid stock. This form is characterized by a heavy, lamellar shell, prosogyrate beaks, a marginal, posteriorly produced ligament, and possibly an incipient dentition. The most significant feature, namely, the character of the muscle impressions, is doubtful: the form has been commonly accepted until recently as monomyarian. Morris, however, observes "there is one large impression posteriorly and perhaps a small one anteriorly." If the presence of an anterior as well as a posterior scar can be established, *Eurydesma* would, in the opinion of Jaworski, fall in line behind *Heterostrea;* if its absence can be proved, *Eurydesma* should be considered as the ancestral form of the *Gryphæas* and *Exogyras.* It is *Heterostrea steinmanni* Jaworski which its describer considers the true ancestor of the true oyster.

The line of development between the two forms is, in his opinion, well defined, and easy to follow: the degree of coiling of the umbones is functional upon the ratio of the size of the left valve to the adhering surface; the larger the area of cementation, the stronger the tendency toward an elongate outline and straightened umbones; with the change in the direction of the beaks, there is a corresponding shift of the ligament from its original position along the posterior margin to a more effective point of attachment directly beneath the tips of the umbones. The obsolescence of the anterior adductor is doubtless the result of the shift of the antero-posterior axis consequent

upon the readjustment of the soft parts of the animal.

Jaworski evolves and develops another theory of phylogenetic relationship which seems so untenable that it may be disregarded—namely that the strongly plicated oysters such as the *Ostrea edulis* are the descendants of the strongly plicate *Gryphæas* of the Mesozoic. The surface sculpture is not a fundamental character among the oysters and there is no reason to search for its cause in distant ancestral relationships. Regarding the phylogenetic significance of *Heterostrea steinmanni* it would seem that it was an entirely too specialized form to have given rise to the subsequent *Ostrea* stock.

J. A. Gardner

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SPECIAL ARTICLES

THE CHEMICAL DYNAMICS OF LIVING PROTOPLASM

Van't Hoff's formulation of the laws of chemical dynamics has proved so stimulating to various fields of chemistry that it may be expected to be similarly useful if it can be applied to the activities of living protoplasm.

The writer finds that by measuring the electrical resistance of living tissues it is possible to follow the progress of reactions in protoplasm in the same way that van't Hoff followed the progress of reactions *in vitro*. It therefore becomes possible to apply van't Hoff's methods and formulæ directly to protoplasm in its living and active condition. The following example will suffice to show how this may be accomplished.

The electrical resistance of living tissue of the marine alga *Laminaria* was measured by a method which has been previously described.[1] The tissue had in sea-water a resistance of 980 ohms.[2] On being placed in NaCl .52*M* (which had the same conductivity as sea-water) the resistance fell after 10 minutes to 855 ohms and after 20 minutes to 745 ohms: it continued to fall rapidly and finally became stationary at 320 ohms. This represents the death point. The total change produced by the NaCl was 980–320 = 660 ohms.[3] In order to find out whether this change had been produced in such a way as to correspond to a known type of chemical reaction the amount of change was measured at brief intervals. The results are given in Table I.

TABLE I

t=time in Minutes	Resistance	x=loss of Resistance	$a-x$	$\frac{a}{a-x}$	$\log_{10}\frac{a}{a-x}$	$k=\frac{1}{t}\times\log_{10}\frac{a}{a-x}$
0	980	0	660			
10	855	125	535	1.234	.0913	.00913
20	745	235	425	1.553	.1911	.00955
30	655	325	335	1.970	.2944	.00981
40	590	390	270	2.444	.3881	.00970
50	540	440	220	3.000	.4771	.00954
60	495	485	175	3.771	.5764	.00961
70	465	515	145	4.551	.6581	.00940
80	440	540	120	5.500	.7403	.00925
90	405	575	85	7.765	.8901	.00989
100	395	585	75	8.800	.9444	.00944
110	380	600	60	11.00	1.0414	.00947
120	366	614	46	14.35	1.1568	.00964
130	359	621	39	16.91	1.2281	.00 45
140	351	629	31	21.29	1.3282	.00949
150	345	635	25	26.40	1.4216	.00948
160	339	641	19	34.74	1.5408	.00963
200	320	660	0	dead		.00953 = Average
250	320	660	0			
300	320	660	0			

a = total change = 980–320 = 660 ohms.
Temperature 18.5° C.

According to van't Hoff we can determine from such measurements whether one, two or more substances are taking part in the reaction. If only one substance takes part (or if two substances take part but only one of them changes its concentration noticeably) the reaction is said to be of the first order (monomolecular) and it proceeds according to the formula

$$k = \frac{1}{t} \log \frac{a}{a - x},$$

in which t is the time which has elapsed between the beginning of the reaction and the taking of the measurements, x is the loss in

[1] Science, N. S., 35: 112, 1912.

[2] If left in sea-water this resistance is maintained for a long time.

[3] The fact that this action of NaCl may be antagonized by $CaCl_2$ does not affect the subsequent discussion.

resistance at the time t, a is the total amount of change in resistance when the reaction is completed and k is a constant (called the velocity constant) which indicates the speed of the reaction. If the reaction is of the first order (monomolecular) k should come out constant provided the temperature be kept constant during the reaction.

In this case a, which represents the total amount of change, is $980 - 320 = 660$ ohms, while x represents the loss of resistance after 10, 20, 30 minutes, etc. In the calculations common logarithms have been employed. It will be seen from the table that k is nearly constant: the variations are no greater than are commonly found in measuring chemical reactions in the test tube.[4] It is probable that they would have been smaller if the temperature could have been kept perfectly constant.

The simplest interpretations of this are as follows. We may suppose that the NaCl reacts with some one substance in the protoplasm but that so little of the NaCl is used up that its concentration changes but slightly.[5] It can be shown by analytical methods that the concentration of the NaCl suffers but little change. In all of the experiments more than 1,200 c.c. of NaCl $.52M$ were employed to 10 c.c. of tissue.

It should be added that if a series of reactions is involved what we measure is practically the rate of the slowest of the series.

An alternative interpretation is that the loss of resistance is due to the spontaneous change of some one substance in the protoplasm, a process which goes on with extreme slowness until catalyzed by the NaCl. This view is of great interest because it implies that the process of death is always going on even in a healthy and growing cell.

If we suppose the NaCl to act as a catalyzer it may be that the reaction which it accelerates is the hydrolysis of some substance in the protoplasm. This would behave as a reaction of the first order since the concentration of neither the NaCl nor the water would undergo much alteration. The reaction might be compared to the hydrolysis of cane sugar (when catalyzed by acid) which behaves as a reaction of the first order.

On this view death would be due to the hydrolysis of some substance (probably protein) in the protoplasm. There is a variety of evidence that death is accompanied by such hydrolysis.

We should not overlook the possibility that the opposite process (dehydration) would give quite the same result. Death is often accompanied by the coagulation of certain proteins. According to some authors coagulation involves dehydration while according to others it is a process of hydrolysis.[6]

We may now consider other possible suggestions. One is that the progress of the reaction is determined not by the number of substances taking part but by diffusion. The NaCl[5] diffuses inward (and the other salts outward) rapidly at first, then more and more slowly, thus affording a certain likeness to the curve of a reaction of the first order. The incorrectness of this interpretation is shown by a study of the temperature coefficient. The temperature coefficient of diffusion is low, the increase in the rate of diffusion being less than 30 per cent. for an increase of 10° C. The increase in the velocity of the reaction of NaCl with living protoplasm amounts to over 150 per cent. for an increase of 10° C., which

[4] The most constant value of k is obtained when the material is sound and is taken directly from the ocean just before the beginning of the experiment. The temperature should not be allowed to rise much above that at which the plants have been growing. The fronds should be neither too old nor too young, and should not have reproductive organs. Fronds should be selected which have the mechanical properties requisite to cause the disks to lie flat in the apparatus when it is closed, but to separate spontaneously when it is opened. Failure to realize these conditions, as well as other imperfections in technique, may produce irregular fluctuations in the value of k.

[5] This applies as well if we suppose that the NaCl in uniting displaces some other substance (*e. g.*, $CaCl_2$) provided the latter is not allowed to accumulate too much in the solution.

[6] The addition or splitting off of H ions would also behave as a reaction of the first order.

shows clearly that we are dealing with a chemical reaction. We must, therefore, exclude the interpretation that diffusion is the determining factor.[7]

Another suggestion is that the result is due merely to the fact that the majority of the cells are more accessible to the reagent or less resistant to it than the rest, so that more cells are killed in the first minute than in the second and so on. But if this were the case we could not, after a lapse of ten minutes (when the loss of resistance already amounts to 125 ohms), restore the tissue to its initial resistance by replacing it in sea-water. This can be done and there is no evidence that the tissue is in any way injured by such treatment with NaCl.[8] The same piece of tissue may be treated with NaCl (for five minutes) and replaced in sea-water several times each day for ten days in succession without showing any sign of injury.[9]

This leads us to the following conclusion. Since the effect of NaCl is within wide limits completely reversible, without production of injury, *the conception of the chemical dynamics of living protoplasm here developed applies not only to reactions which produce death but also to reactions which involve no injury and which form a normal part of the activity of the cell.* This conclusion is fully confirmed by experiments with a variety of other substances.

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[7] There are other important reasons opposed to the suggestion that diffusion is the determining factor. One of these is the length of time required for the process. If tissue is transferred from sea-water to sea-water diluted with one or two volumes of distilled water, there is a change of resistance which continues until equilibrium has been restored by diffusion. This process at 18° C. does not take more than ten minutes, whereas nearly three hours would be required for the reaction with NaCl which we have been measuring.

[8] This and other experiments show that the increase in the conductivity of the protoplasm is not to be attributed to an increase in the concentration of electrolytes within the cell but rather to a decrease in the viscosity of the protoplasm (or to an increase in some other factor which facilitates the passage of ions).

[9] Science, N. S., 36: 350, 1912.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION H—ANTHROPOLOGY AND PSYCHOLOGY

At the recent annual meeting of the American Association for the Advancement of Science held at Atlanta, Georgia, December 29 to January 2, Section H—Anthropology and Psychology—participated in four sessions. Tuesday afternoon was devoted to a "general interest" session at which Professors Max Meyer and Lightner Witmer spoke. Wednesday morning was given over to a joint meeting with the Southern Society for Philosophy and Psychology; Thursday morning to a joint session with Section L—Education, and Thursday afternoon to a joint session of all three of these organizations. In all some twenty-two papers were presented.

The following officers were elected: *Vice-president of the Association and Chairman of the Section,* Dr. Clark Wissler, of the American Museum of Natural History; *Member of the Sectional Committee* (to succeed Dr. G. A. Dorsey), Professor Lightner Witmer, of the University of Pennsylvania; *Member of the Council,* Professor Max Meyer, of the University of Missouri; *Member of the General Committee,* Professor L. R. Geissler, of the University of Georgia.

The following twelve papers were presented under the auspices of Section H:

The Present Problems of Physiological Psychology: Max Meyer.

Psychologists generally are beginning to realize that the study of consciousness is only a secondary, an auxiliary branch of psychology. But it is a mistake to think that psychology can be defined simply as the study of behavior. The study of plant behavior is the business of the botanist. Nothing forbids, of course, interest in plant behavior on the part of the psychologist save common sense, which would call a man a botanist if he is more interested in plant behavior than in human life. In a similar way the study of animal behavior must be regarded as primarily the task of the zoologist. And the study of human behavior seems to be largely the province of the sociologist (including under "sociology" as a special branch the science of education). Is then

nothing left for the psychologist as his proper field? My answer is that it is the psychologist's business to make comprehensible that link which is interposed between our sensory surfaces and our muscles, the function of the nervous system. Apparently, this demand is supplied by a scientist who, again, is not the psychologist—by the physiologist. As a matter of fact, however, a text-book on the physiology of the nervous system, even such as Sherrington's or Loeb's, would not suit the needs of a college class in psychology. I should say, therefore, that the psychologist's task consists in making comprehensible the function of the nervous system as the chief determiner of all those varied forms of human behavior which we find described in a good novel, in the drama, in biography, in history, in the newspaper. In order to illustrate this task, a number of typical problems were discussed and solutions proposed.

Children with Mental Defects Distinguished from Mentally Defective Children: Lightner Witmer.

"Were society so organized that success in life in every sphere of activity were dependent upon a good enough ear to turn a tune, many persons who are now doing useful work in the world would have to be relegated to the class of imbeciles." Several cases were reported, among them the case of a boy who at fourteen years, although he was normal in appearance and behavior and had been attending school regularly, was at the educational stage of a child of seven. He was unable to read for himself, for pleasure or profit, and his spelling was as deficient as his reading. When he wrote a letter it was impossible to make out his meaning without knowing what he had intended to say. Careful examination showed that the boy was suffering from a language defect, psychologically a defect of memory. There was both a weakness in retaining new impressions and a weakness in the recall of impressions which had been received and partially retained. He was word deaf as well as word blind, or, to put it scientifically, he was a case of congenital aphasia. "Congential aphasia is a more serious defect to the individual than the lack of an ear for music, because of the social and industrial importance of speech; perhaps also because a certain measure of language development is essential for accurate thinking. . . . I regard the child, for that matter the adult also, as composed of a number of traits, some of them assets if they favor normal mental development and success in adult life; some of them defects if they provoke retardation, arrested development, delinquency and crime. There is no so-called normal person who does not possess some defects along with his assets. The type of child in whom I am especially interested and for whom I organized and am directing the work of the psychological clinic at the University of Pennsylvania, is the child who has so many and such severe mental defects as seriously to interfere with normal development in the home and in the school and to prognosticate his arrival at adult age arrested in mental and moral development. Because a child has one or a few mental defects, we must not characterize him as mentally defective. . . . A strictly scientific nomenclature will dispense with the term 'mentally defective,' as failing to characterize with sufficient definiteness the class of children under consideration. What characterizes 'mentally defective' children is not that they are mentally defective, for other children, in fact all children, are mentally defective, but that they are so defective mentally as to be socially unfit. For the term 'mentally defective' I would therefore propose substituting the term 'socially unfit' or 'socially defective.'"

Published in *The Psychological Clinic*, Vol. VII., No. 7, December 15, 1913.

Some Fundamental Concepts in Social Psychology: L. R. Geissler. (By title.)

Correlation of Mental and Physical Measurement: Jasper C. Barnes.

The correlations described in this paper are based upon the physical measurements of one hundred students, members of the psychology class in Maryville College, during the year of 1912–13 and the fall term of 1913. The list includes fifty young men and fifty young women representing all of the four college classes and twenty different states. The average age of the young men was 21.7 years, while the average age of the young ladies was 21.3 years. The youngest in each case was 17. The oldest young man was 26, and of the young ladies 31. The mental measurements are in terms of grades received by the students in their various studies, and hence are not mental measurements in the laboratory sense at all. The physical measurements were five: height, weight, vital capacity, length and width of head. The apparatus used was the stadiometer, anthropometric scales, wet-spirometer and head calipers.

According to the method of group comparison there seems to be very little relation between height and scholarship, or weight and scholarship. But between the vital capacity and mental abil-

ity there appears to be some correlation by the method of comparison, yet when computed by Pearson method the index of correlation is very small. The coefficients of correlation calculated by the Pearson method are as follows:

	Men	Women
Weight and class standing......	.056	.052
Height and class standing......	.023	.216
Vital capacity and class stdg....	.085	.245
Cephalic index and class stdg....	—.033	—.151

In summing up the foregoing, it appears that the measurements in this series have little interdependence.

The index of correlation except in the case of the vital capacity of women, is a negligible quantity. However, the number of cases is too small in our investigation to justify the statement of any general conclusion or law. It may be said, nevertheless, in the hundred cases studied, there seems to be little, if any, correlation between mental ability, as shown by class standing of college students, and height, weight, lung capacity and cephalic index.

The Causes of the Declining Birth-rate: J. McKeen Cattell.

The completed family of contemporary scientific men is about 2, the surviving family about 1.8 and the number of surviving children for each scientific man about 1.6. Twenty-two per cent. of the families are childless; only one family in seventy-five is larger than six. The same conditions obtain for other college graduates. The speaker discussed the biological causes through which the fertility of a woman has been limited to an average of about twelve children, the social causes which lead about one half of all women of child-bearing age to remain unmarried, and the pathological and psychological causes which give the present family of two or three children. Answers had been received from 461 leading scientific men giving the causes which led to the limitation in the size of their families. One hundred and seventy-six were not voluntarily limited, while 285 were so limited, the cause of the voluntary limitation being health in 133 cases, expense in 98 cases and various other reasons in 54 cases. Childlessness was involuntary in two thirds of the cases. In the standardized family of two the condition is desired in six cases out of seven. In over one third of the families the limitation was involuntary, due to infertility and other pathological causes, but if these had not obtained, voluntary limitation would have occurred in nearly all or perhaps in all cases.

On the Effect of Adaptation on the Temperature Difference Limen: Edwina Abbott.

The effect of adaptation to different temperatures on the difference limen for 40° C., 37.5° C., 35° C., 32.5° C., 30° C., 27.5° C., 25° C., 22.5° C., 20° C. and 17.5° C. was determined. Water was used as the adaptation medium and was kept at any desired temperature by means of an electric heater controlled by an electric thermostat. The fingers of both hands of the subject were adapted to a certain temperature as far as the second joint and when adaptation was complete the fingers were raised and those of one hand dipped into water of the standard temperature and those of the other hand into water of the variable temperature for the difference limen test. The method of right and wrong cases was used in determining the limen and the fingers readapted before each test. Four trained subjects were used.

The results indicate that: (1) The difference limen for a given temperature after a given adaptation temperature is relatively constant for a given individual; (2) the absolute amount of the difference limen under such circumstances differs for individuals, but the relation between the limina for different temperatures after any given adaptation temperature remains the same for different individuals; (3) the point of greatest sensitivity to difference lies at 32.5° C.; (4) the preceding adaptation temperature affects the difference limen for a given temperature, the difference limen, in general, increasing as the adaptation temperature varies from the standard temperature; except for 32.5° C. where the difference limen remains constant under all conditions of adaptation.

Eventually to appear in the *Psychological Review*, Monograph Series.

A Study of the Behavior of the Chick: Ada Hart Arlitt.

In February of 1913 work suggested by that of Feré on the effect of alcohol on the physiological development of the chick was undertaken in the biological laboratory of Newcomb College. It was found possible to raise healthy chicks from eggs which had been subjected to alcoholic treatment, but the behavior of these chicks differed from that of normal chicks hatched in the same incubator at the same time.

The reactions to light and the pecking and drinking reactions of the abnormal chicks differed but little from those of normal chicks.

Abnormal and normal chicks were placed on stands from 10.7 cm. to 179 cm. above the box in which they were kept and the height at which they refused to jump recorded. The abnormal chicks jumped from greater heights.

To determine the difference in rapidity of learning three mazes were used, one a straight path blind at one end, one a simple choice maze with the exit on the left side, the third the Yerkes apparatus.

The chicks were given ten trials each in each of the first two mazes and the time taken to find the exit recorded. Abnormal chicks learned their way out of the first maze almost as swiftly as normal chicks, but learned their way out of the second much more slowly, making many wrong choices. Two failed to learn the way out.

With the Yerkes maze the number of trials taken before the chick made ten consecutive right choices was recorded. The exit was on the right side. The normal chicks learned the way to the exit in 8 trials, the abnormal in from 23 to 45 trials.

Two Factors which Influence Economical Learning: EDWARD K. STRONG, JR.

The paper presented the results of a number of experiments in the field of advertising and discussed their bearing upon studies that have been made in the field of economical learning.

The general conclusions were as follows: (1) Repetitions of advertisements a few minutes apart or a week apart are about equal in efficiency when tested four months later, but both such intervals are superior to repetitions a month apart. On the basis of all the work in this field, it would seem that the optimum interval for repetition is one day. (2) The more impressions made at one time, the less is the permanent retention of any one of them. This is probably due to the effect of retroactive inhibition. (3) In any situation when both length of interval and the number of impressions to be made at any one time are concerned, it should be borne in mind that the second factor is far more important than the first. This means that further work should be directed more particularly to a better understanding of how many impressions can be made to advantage at any one time, rather than to the proper interval of time between their successive presentations.

Published in the *Journal of Philosophy, Psychology and Scientific Methods,* Vol. XI., No. 5, February 26, 1914.

Psychological Characteristics of the African Negro: JEROME DOWD.

Professor Dowd divided Africa into economic zones, and contrasted the characteristics of the people of each zone.

"The instinct of flight is very pronounced in the banana zone. Nature is here manifested in a very violent form—exciting terror and gross superstitions. It is a zone of idols, fetichism, witchcraft and the magic-doctor. In the agricultural zones nature is less antagonistic, and the struggle for existence more severe, requiring more reason and courage. Here the emotion of fear is less pronounced—the number of idols diminishes, and the magic-doctor uses less hocus pocus and more medical art. In the cattle zone, where nature is still less violent and terrifying and the climate and other conditions more conducive to action, we observe still less fear among the people, less use of idols, witchcraft and magic-doctors.

"The instinct of pugnacity is weak in the banana zone because of the intensity of the feeling of fear. It is more pronounced in the agricultural zones, and very much so in the pastoral zones where the conditions provoke chronic warfare. This instinct is of great value to any race—since, under peaceful conditions, it is carried over into all lines of activity. Instead of the war of fire and sword, we have the war of tools, machinery, commodities and ideas. From the games played by children and adults up to the rivalry of nations for intellectual and moral supremacy we see the play of this primitive instinct. The nations that now occupy the highest rank in the industrial rank in intellectual and moral development are precisely those which have gone through the fiercest and most prolonged era of warfare.

"The gregarious instinct is remarkably developed in the central regions of Africa where the bounty of nature permits of the living together of large groups. It is not quite so well developed in the other zones, although it is everywhere very characteristic of the African Negro. In the lower stages of society this instinct serves the useful purpose of insuring to aggregations of people the development of laws and institutions. McDougall believes that this instinct is less important for civilized people and often produces anomalous and even injurious social consequences in large cities. According to Giddings and McDougall, this instinct is due to consciousness of kind. I believe, however, that people are attracted to each other by unlikeness, and the so-called instinct of gre-

gariousness is nothing but the expression of the instincts of fear and curiosity."

Reason, imagination, inhibition and other characteristics were discussed.

A Comparison of White and Colored Children Measured by the Binet Scale of Intelligence: JOSIAH MORSE.

Two hundred and twenty-five white and one hundred and twenty-five colored children in the public schools of Columbia, S. C., were tested; ages ranging from six to twelve, inclusive. Results: The number of white children testing *at age* is decidedly larger than any other group, whereas for the colored children the largest group is the one testing one year below age. In the satisfactory group there is a difference of nearly 15 per cent. between the white and colored; nearly three times as many colored are more than a year backward, and less than one per cent. are more than a year advanced.

The picture tests, those relating to time and money, distinguishing between morning and afternoon, enumerating the months, counting stamps and making change, the drawing tests, both copying and reproducing from memory, were all too difficult. The answers to the questions of comprehension, to the absurd statements and to the problems of various facts, were often absurd or senseless; the best replies, however, compare favorably with those of the white children. The definitions were often not better than terms of use, and frequently stated in the language of a younger child.

Compared with the white, the colored children excelled in rote memory, *e. g.*, in counting, repeating digits—though not one was able to repeat 26 syllables—naming words, making rhymes, and in time orientation. They are inferior in esthetic judgment, observation, reasoning, motor control, logical memory, use of words, resistance to suggestion, and in orientation or adjustment to the institutions and complexities of civilized society.

A rough classification into three groups, according to color—dark, medium, light—showed that the darkest children are more nearly normal, the lightest show the greatest variation, both above and below normal.

The paper appeared in the January number of *Popular Science Monthly*, Vol. LXXXIV, No. 1, January, 1914.

A General Intelligence Test: L. R. GEISSLER.

Minor Studies in Learning and Relearning: DAVID SPENCE HILL.

The studies presented were from the standpoint of an instructor in educational psychology for college classes, and illustrate useful methods of individual and class experimentation. The studies consist of three series. The first is descriptive of material for and uses of mirror-drawing. One subject practised drawing stars for forty-eight days. Three years afterward the trials were resumed, and it was found that in about three trials the former speed and accuracy were attained. Analysis of the relearning does not show evidence that "the mind continues its activity for a time in the furtherance of a learning process after practise and study have ceased," as suggested in the similar experiment of Swift.

In the mirror-drawing experiment, by initial and terminal tests before and after the above practise, an interesting demonstration was made of the regulation of transfer effect, both to right and left hands. This was accomplished by the use of slightly dissimilar geometrical figures, by the use of which there were found fairly consistent differences in net results of improvement.

The second study is a class experiment employing substitution tests. A group of ten students participated during twelve days. A presentation of the problems of intervals of study, the method of equal groups, the question of individual differences before, during, and after practise is included.

The third series consisted of cancellation experiments the object of which was to illustrate a convenient form of A-test suitable for group or individual use. In constructing the form, twenty-six marbles were marked with the letters of the alphabet, shaken in a small basket and thereupon a marble was withdrawn. After the letter was written down another mixing and withdrawal was made, and finally the MS. thus constructed was printed by a linotype. This method of distributing the twenty-six letters, although laborious, secured for practical purposes one hundred alphabets arranged in chance order. A group test during fourteen days was made upon the effect of practise in making A's and concerning the transfer of the improved capacity to marking words containing e and r, from a Latin text. The results are not inconsistent with those of Thorndike.

The paper will appear in the *Journal of Educational Psychology.*

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